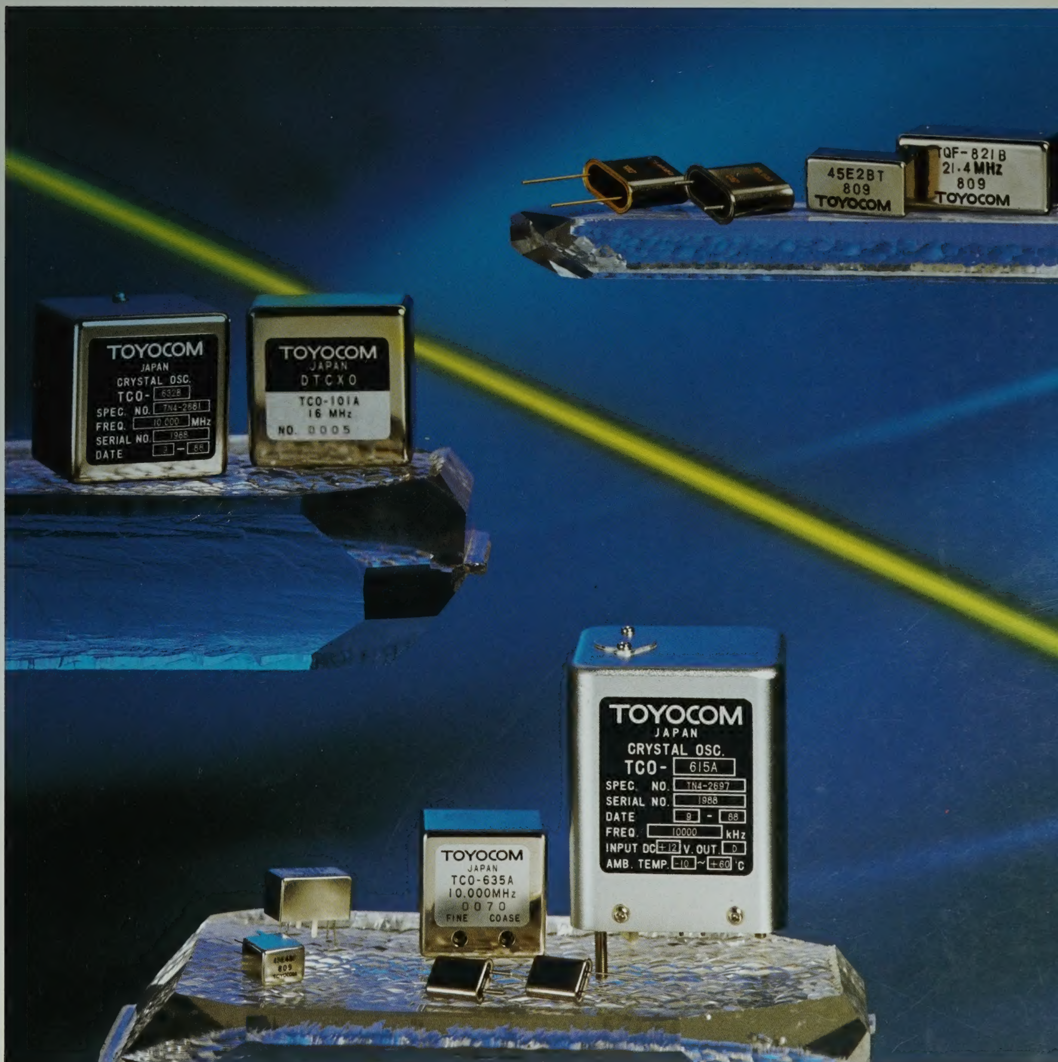
TOYOCOM

Crystal Units, Crystal Filters
Crystal Oscillators



1992/1993

CONTENTS

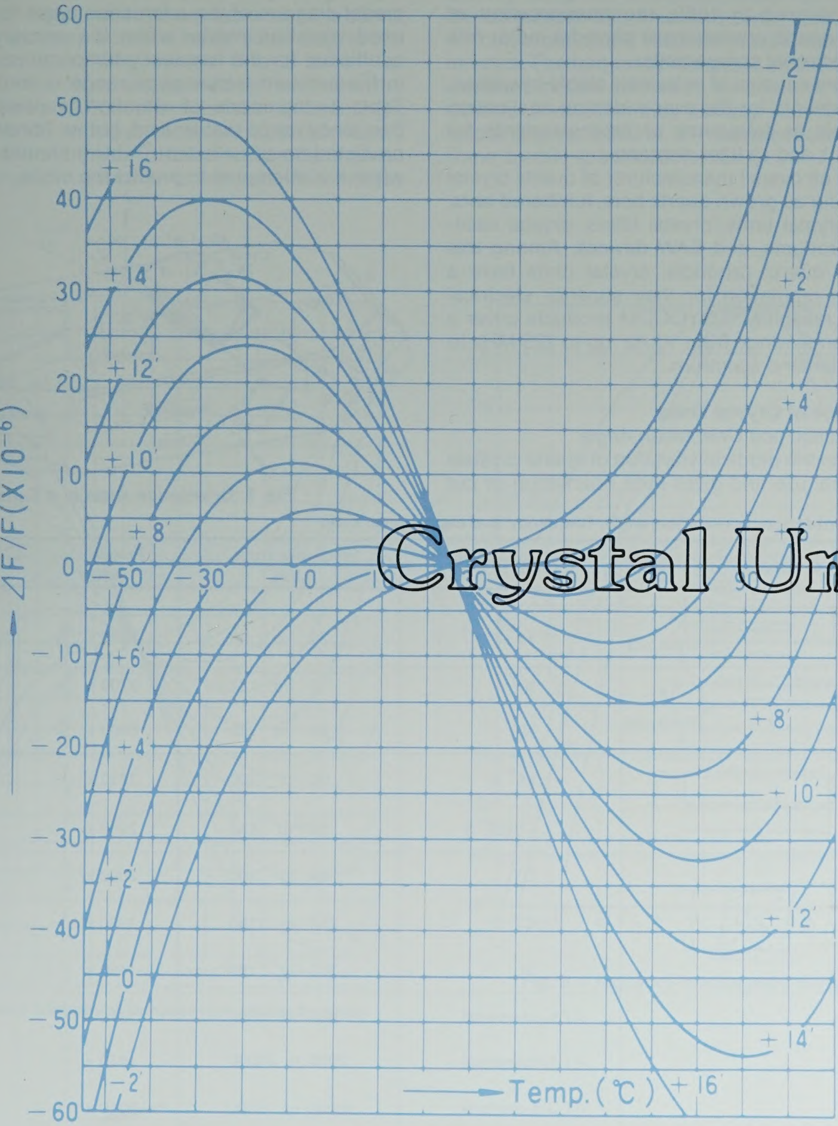
Introduction

TOYOCOM is the pioneer of the crystal industry in Japan, and has been supplying both domestic and overseas customers with quality crystal products for over half a century. TOYOCOM products have steadily enjoyed a good reputation in the market. In 1960, TOYOCOM was the first in Japan to successfully mass produce synthetic quartz crystals. Since then, TOYOCOM has expanded its crystal products line from materials to components as well as accumulating crystal technology.

Today, TOYOCOM is one of the leading crystal manufacturers in the world and has a broad products line consisting of quartz bars, blanks, optical devices, crystal units, crystal oscillators (TCXO, OCXO), SAW resonators, SAW filter, crystal filters, monolithic crystal filter, crystal clock oscillators and micro-processor crystals which meet the growing demand in the fields of communications, computers and so on.

This catalog lists a varietyof crystal units, filters.and oscillators for cellular mobile telephone, cordless telephone and VHF/UHF band radio communications. TOYOCOM is proud of its excellent quality, "just-in-time" delivery, competitive price and customer serice. You can count on TOYOCOM.

Crystal Units



GUIDANCE AND DEFINITIONS

I. General

Since the famous Curie brothers, the great French physicists, discovered in 1880, the phenomenon of piezoelectricity, quartz crystals have played a major role in the area of electronic components.

Crystal units are capable of extremely stable operation. This stability accounts for the ever-widening application of quartz crystals as frequency or time standards for frequency control, and as filter elements.

TOYOCOM is an overall manufacturer of quartz crystal products including as grown quartz bars, lumbered bars, crystal wafers crystal units, crystal filters, crystal oscillators, optical products, and SAW devices. Among this large variety of quartz products, crystal units have a particularly high reputation for their superior electrical capabilities and reliability. TOYOCOM products cover a very wide frequency range from 1 kHz up to 225 MHz to meet the entire demand spectrum.

II. General Outline of Crystal Units

(1) Mode of Vibration and Orientation Angle

Table 1 refers to the mode of vibration of quartz crystals that are in general use and gives their orientation or cut angle, frequency range, relations between wafer dimension and frequency, and capacitance ratio. Fig.1 represents a model diagram of the orientation angle for the generally used vibration mode, when the primary temperature coefficient for the frequency-temperature characteristics in the ambient temperature range is zero. As shown in Table 1, the mode of vibration is determined by the frequency range that is used, but its vibration can also be predicted, to some extent. Table 1 should be referred to, when it is attempted to predict the mode.

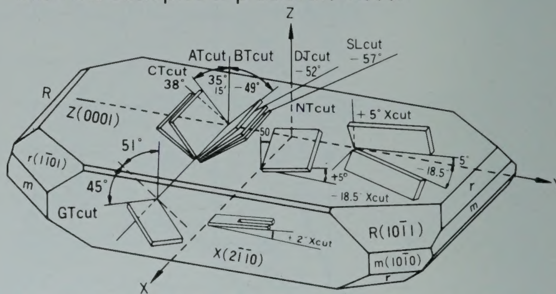
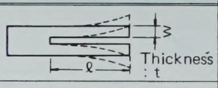
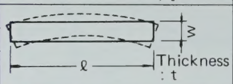
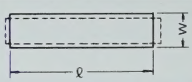
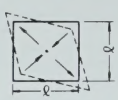
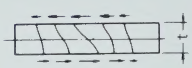


Fig. 1 Orientation angle of a Z-plate quartz crystal

Table 1 Mode of vibration, orientation angle, frequency and capacitance ratio

Mode of vibration		Orientation angle	Frequency range (kHz)	Frequency (kHz)	Capacitance ratio (Approx.)
Tuning fork		$+2^\circ$ X	24 to 50	$770 \times \frac{w}{\ell^2}$	450
Flexure		XY	1 to 21	$5700 \times \frac{t}{\ell^2}$	600
		NT	21 to 85	$5000 \times \frac{w}{\ell^2}$	900
Extensional		$+5^\circ$ X	50 to 200	$2730 \times \frac{1}{\ell}$	140
		-18.5° X	60 to 650	$2550 \times \frac{1}{\ell}$	140
Face Shear		DT	84 to 300	$2080 \times \frac{1}{\ell}$	450
		CT	250 to 1150	$3080 \times \frac{1}{\ell}$	400
		SL	300 to 1150	$(460 \times \frac{1}{\ell})$	450
Thickness Shear		AT fundamental	800 to 5000	$1670 \times \frac{1}{t}$	300~450
		AT fundamental	2000 to 30000	$1670 \times \frac{1}{t}$	230
		AT 3rd overtone	30000 to 75000	$5010 \times \frac{1}{t}$	(2500)
		AT 3rd overtone (EFD)	30000 to 100000	$5010 \times \frac{1}{t}$	(2500)
		AT 5th overtone	50000 to 125000	$8350 \times \frac{1}{t}$	(7500)
		AT 7th overtone	100000 to 225000	$11690 \times \frac{1}{t}$	(17000)
		BT fundamental	2000 to 38000	$2560 \times \frac{1}{t}$	650

(2) Orientation Angle vs. Frequency-Temperature Characteristics

The frequency-temperature characteristics of a quartz crystal can be grouped into two types according to the shape of the corresponding curves. One is ternary or third-order, and the other a quadratic or second-order curve. Fig.2 shows an AT cut characteristic representing a third-order curve. AT cut crystal units are most extensively used and are characterized in that they produce small frequency changes in response to temperature changes in the ambient temperature range. Fig.3 gives the frequency-temperature characteristics for various cuts that are consistent with a second-order curve. Excluding the AT cut, most of the vibration modes have these characteristics. The frequency-temperature characteristics of the vibration modes defined in section (1) need checking to determine whether they comply with the equipment or machine specifications. AT-cuts are recommended unless some special specifications apply.

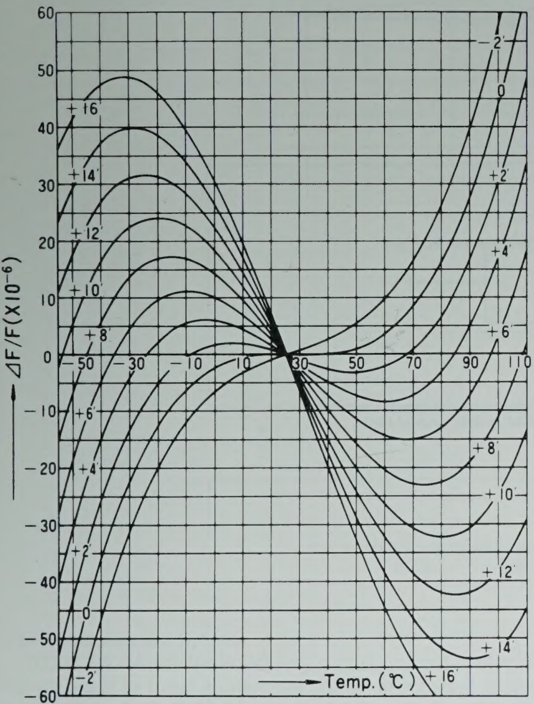


Fig. 2 AT-cut frequency-temperature characteristics

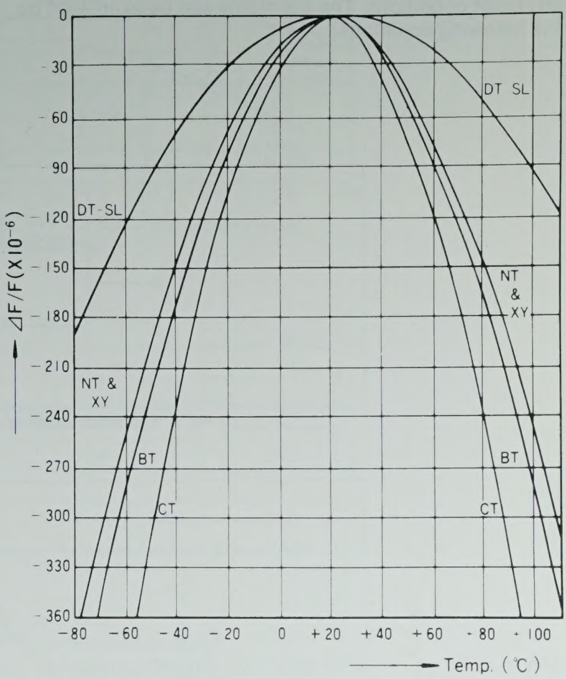


Fig. 3 Frequency-temperature characteristics

GUIDANCE AND DEFINITIONS

(3) Equivalent Circuits and Constants

Quartz crystal units can be expressed in terms of the equivalent circuits of Fig.4 in the vicinity of the resonance frequencies. These equivalent circuit contants are:

L1: motional inductance
C1: motional capacitance
R1: series resistance
Co: shunt capacitance

Fig.5 gives the admittance loci for the quartz crystal unit. As can be seen from this diagram, there is a particular relationship between the equivalent circuit form and the frequency as well as the resistance for each and all circuit conditions. The constants can be expressed by the following equations:

fs (Series resonance frequency)	$= 1/(2\pi\sqrt{L1C1})$
fp (Parallel resonance frequency)	$= 1/[2\pi\sqrt{L1 \cdot C1 \cdot Co/(C1+Co)}]$ $= fs[1+1/(2\gamma)]$
γ (Capacitance ratio)	$= 2\pi \cdot fs \cdot Co/C1$
Q (Quality factor)	$= 2\pi \cdot fs \cdot L1/R1$ $= 1/(2\pi \cdot fs \cdot C1 \cdot R1)$
M (Figure of merit)	$= Q/\gamma = 1/2\,(2\pi \cdot fs \cdot Co \cdot R1)$

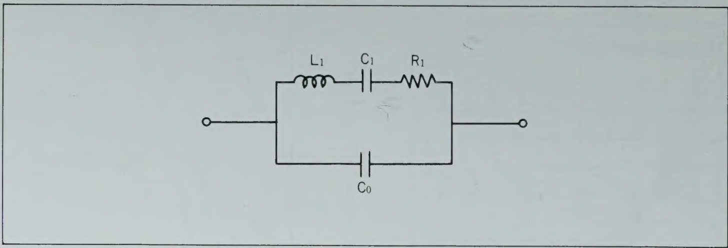


Fig. 4 Equivalent electrical circuit of quartz crystal unit

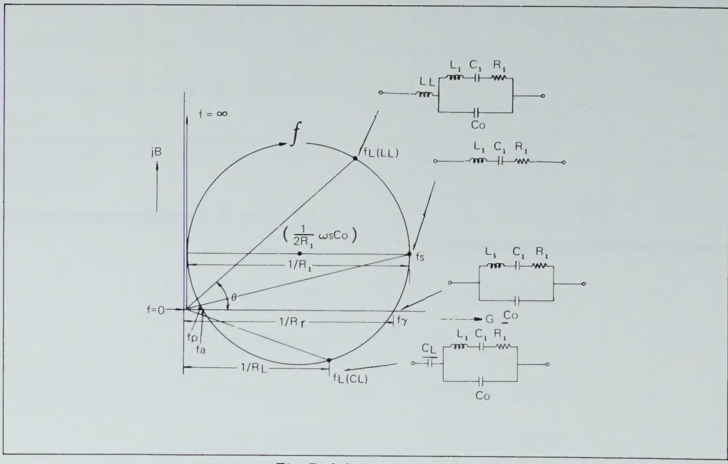


Fig. 5 Admittance locus

(4) Frequency-Aging Characteristics

TOYOCOM has established a long tradition and continuity in developing and supplying quartz crystal units with outstanding aging characteristics. Fig.6 shows the typical frequency-aging characteristics of various crystal units. Fig.7 represents the aging characteristics of high-precision crystal units.

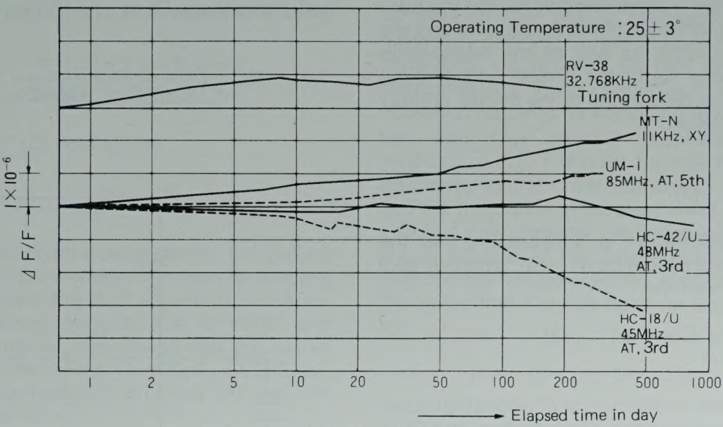


Fig. 6 Frequency Aging Characteristics

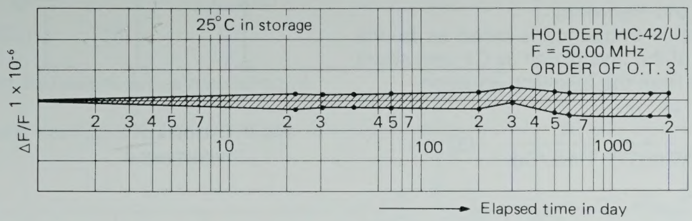


Fig. 7 Frequency Aging Characteristics of Reference Oscillator Crystal Units

(5) Measurement System

TOYOCOM has the following measurement systems at its disposal to meet a universal spectrum of user requirements.

1. Crystal Impedance Meter TS-710/TSM
   Frequency Range: 2.5 to 1100 kHz (to US military standards)
2. Crystal Impedance Meter TS-330/TSM
   Frequency Range: 1.0 to 15 MHz (to US military standards)
3. Crystal Impedance Meter TS-683/TSM
   Frequency Range: 10 to 140 MHz (to US military standards)
4. Crystal Impedance Meter AN-15/TSM
   Frequency Range: 75 to 200 MHz (to US military standards)
5. π-network method
   Frequency Range: 1.0 to 225 MHz (to IEC pub. 444)

The crystal impedence meters listed above use the oscillation method. The advantage of this system is that it provides a simple measurement method, allowing high excitation level measurement over a wide frequency range. Its disadvantage, however, is that it has inferior accuracy. The π-network method, however, has high measurement accuracy and permits measurement at a low excitation level.

At high frequencies exceeding the frequency range, the round-robbin technique provides mutual interchangeability within 0.5 ppm using the π-network method.

III. Crystal Oscillator Circuit

To construct oscillator circuits with crystal units, it is necessary to take the following details into consideration.

(1) Example of a Basic Oscillator Circuit (for Fundamental)

Fig.8 shows basic oscillator circuit (for fundamental). If oscillation occurs under normal conditions, the relationship between the reactance Xe of the crystal unit and the reactance -X of the circuit, as well as the relationship between the impedance Re of the crystal unit and the impedance -R (negative resistance) of the circuit, comply with the following equation.

$$Xe = -X$$
$$Re = |-R| \ldots (1)$$

To ensure stable oscillation, it is necessary that the impedance of the circuit should be $-R > Re$. When we take the example of Fig.8, we have

$$-R = -gm/(\omega^2 \cdot C_{01} \cdot C_{02}) \ldots (2)$$
$$= -1.55\ k\Omega$$

Where gm is the mutual conductance of oscillation stage transistor, ω is angular frequency of oscillation, and Cv is the trimmer capacitor for frequency adjustment.

(2) Load Capacitance and Frequency

If the series resonance frequency is taken as fs, the motional capacitance of the crystal unit as C1, and shunt capacitance as Co, we have the following equation:

$$\frac{\Delta f}{fs} = \frac{fL - fs}{fs} = \frac{1}{2(Co/C1)} \cdot \frac{1}{1 + CL/Co} \ldots (3)$$

if the resonance frequency with the load capacitance is fL and difference between fL and fs is Δf.

In the example of Fig.8, the load capacitance may be considered as being the capacitance of C_{01}, C_{02}, and C_{03} + Cv connected in series if the stray capacitance of transistor and pattern are included. In other words, the load capacitance CL is

$$CL = \left(\frac{1}{C_{01}} + \frac{1}{C_{02}} + \frac{1}{C_{03} + Cv}\right)^{-1} \ldots (4)$$

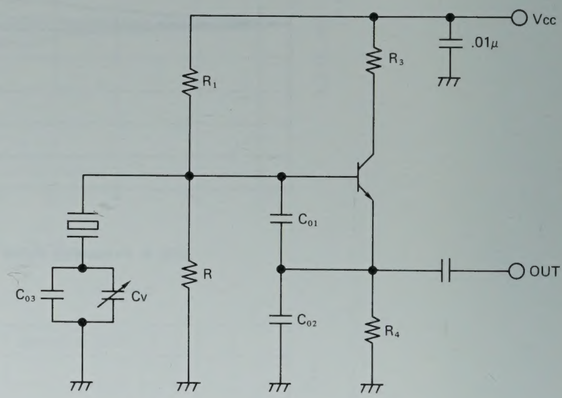


Fig. 8 Example of a oscillator circuit with a 10 MHz fundamental

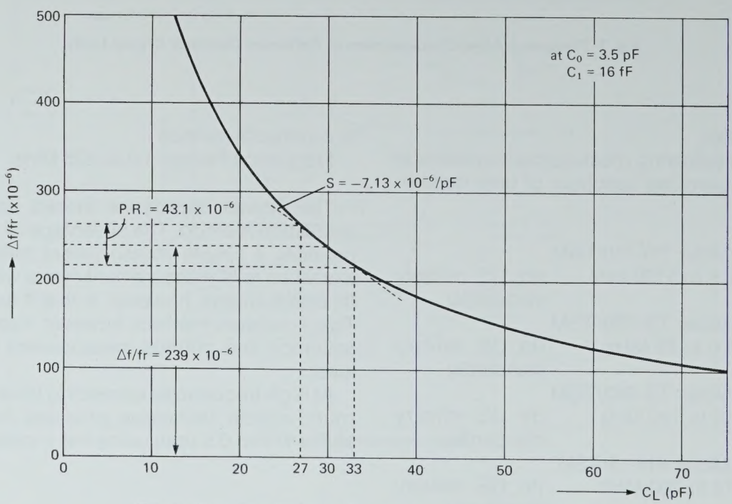


Fig. 9 Characteristics of frequency vs. load capacitance

If we assum that the manufacturing tolerance for a crystal unit is in the order of ±10 ppm, it will be necessary to have a trimmer Cv to change the frequency to an extent of ±15 ppm so as to compensate the variation of the circuit elements and the changes due to aging.

If C1 and Co for the crystal unit are given, and if load capacitance changes from CL1 to CL2, then the "Pulling range" (P.R.) will be:

$$P.R. = \left|\frac{fL1-fL2}{fr}\right| = \left|\frac{C1C1(CL2-CL1)}{2(Co+CL1)(Co+CL2)}\right| \ldots (5)$$

The "Pulling Sensitivity" (S) near CL is:

$$S = \frac{(\triangle f/fr)}{CL} = -\frac{C1}{2(Co+CL)^2} \ldots (6)$$

If CL in equation (6) is given a small value, the pulling sensitivity will increase. Conversely, however, its stability will decrease. Fig.9 shows the load capasitance characteristics for the resonance frequency at C1=16fF and Co=3.5pF. For this purpose, the results that are calculated with substituting the values CL=30pF, CL1=27pF, and CL2=33pF in equation (3), (5), and (6) may be considered as reference data.

It should considered with due care that if, as shown in equation (7) below, the effective resistance RL of the crystal unit has a large value, it has difficulty in oscillations.

$$RL = R1 \cdot (1+Co/CL)^2 \ldots\ldots (7)$$

In this equation, R1 is the equivalent series resistance of the crystal unit.

(3) Overtone Oscillation Circuit (Example)

Fig.10 shows the example of an overtone oscillator circuit. Compared with the fundamental oscillator circuit (Fig.8), it should be noticed that two coils have been added. Let us explain the reason for adding these two coils. First, the coil Lo1 on the emitter side of the transistor consists of C_{02} that is connected in parallel, and a frequency selector circuit. To obtain the desired overtone oscillation, oscillator, a selector circuit is required that suppresses the lower overtones or the fundamental. The condition required for achieving this selectivity, is that the L_{01} and C_{02} parallel resonance frequency fT ($=1/2\pi\sqrt{L_{01} \cdot C_{02}}$) should be intermediate between the frequency of the order number of the desired overtone and the frequency of the next lower overtone.

Let us now consider the negative resistance referred to above as one of the oscillating conditions. Since the selector coil has been added, equation (2) has changed in the sense that C_{02} has become $C_{02}-1/\omega^2 L_{01}$. This gives us:

$$-R = -gm/\left[\omega^2 \cdot C_{01} \cdot (C_{02} - 1/\omega^2 \cdot L_{01})\right]$$

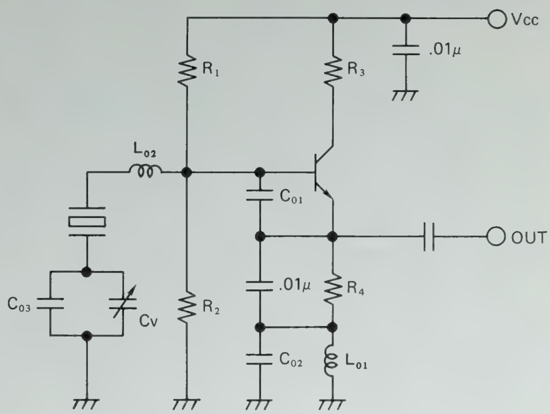


Fig. 10 Example of a standard overtone oscillator circuit

If we take the example of Fig.8 in which -R was -1.55 kΩ and if we use the same C_{01} and C_{02}, then we will see that if the frequency is 75MHz, for example, the negative resistance is as small as -R = -27 Ω.

Consistently, C_{01} and C_{02} have to be given sufficiently small values for the overtones. The overtone oscillator circuit calls for another area of particular care. This is the frequency pulling range. In equation (4), the motional capacitance C1 of the crystal unit with the same thickness and the same electrode dimensions is roughly inversely proportional to the square of the overtone order number.

This, consequently, means that the frequency pulling range becomes narrower as a result. If, however, C_{01} and C_{02} assume small values in order to ensure a negative resistance, then this pullability will be made even more difficult. By contrast, however, this increases the frequency stability with respect to external changes (for example: changes associated with the circuit). The coil L2 is sometimes added to ensure a suitable frequency pulling range. Coil L2 is generally referred to as an expansion coil. As shown in Fig.11, the amount of frequency change from the series resonance, with the expansion coil and load capacitance parallel-connected to the crystal unit, can be expressed as:

$$\frac{\Delta f}{fr} = \frac{1}{2(Co/C1)} \cdot \frac{1}{1+\frac{CL}{Co} \cdot \frac{1}{1-\omega^2 LaCL}} \quad \ldots (8)$$

If La → 0 in equation (8), it should be checked that equation (4) is met. If La is introduced, it should also be checked that the trimming range is increased.

As an example dissociated from the overtone oscillator circuit, Fig.12 shows an example of a pager circuit, a type of circuit that has been increasing particularly in recent years. This type of circuit is particularly designed for applications with a low power supply voltage of 1 to 1.1 V and when a low current consumption is required.

The coil and resistance connected in parallel with the crystal unit respectively, are a Co cancelling coil for the crystal unit and a resistance for avoiding abnormal oscillations. The LC circuit on the collector side of the transistor is a frequency multiplier circuit.

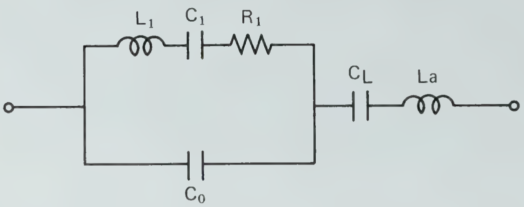


Fig. 11 Equivalent circuit with an added expander coil

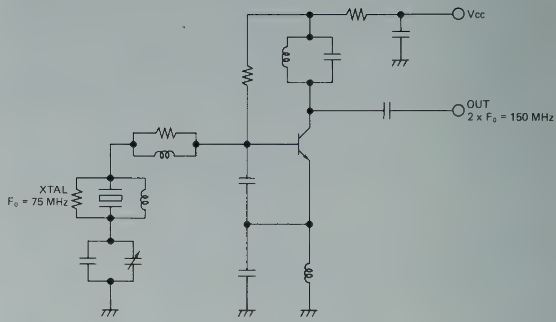


Fig. 12 Example of 1st local oscillator for a pager

(4) Prior to Circuit Pattern Design

If a pattern design is required for a crystal oscillator circuit in the high frequency range, it is the essential to consider the following points.

- To minimize the stray capacitance of oscillation loop, the length of the pattern should be designed as short as possble.
- If other components and the wire pattern are crossed in the oscillation loop, it is essential to suppress the stray capacitance increase to the greatest possible extent.

IV. EFD Series Crystal Unit

The EFD series crystal unit is a revolutionary concept in that it is an overtone crystal unit that can be used as a fundamental crystal unit at the same time.

As has been explained in the previous chapter, a normal overtone oscillator circuit is subject to many limiting conditions and problems. With the present crystal unit, these problem areas have been improved to achieve a simple circuit that does not present any danger of abnormal oscillation and that is capable of achieving a low power consumption.

(1) Principle of the EFD Series Crystal Unit

Fig.13 shows the frequency response characteristics of an EFD series crystal unit. Compared with conventional crystal units, it has a large fundamental series resistance which is several times that of the third-overtone mode.

These characteristics have imparted to the vibrator itself a frequency-selecting capability and have done away with the selector coil described in chapter III, in other words, the tuning coil.

The EFD series crystal unit uses a conventional AT cut wafer and differs from conventional vibrators only in terms of the electrode structure, while all other features are exactly identical with the conventional third overtone AT cut crystal unit.

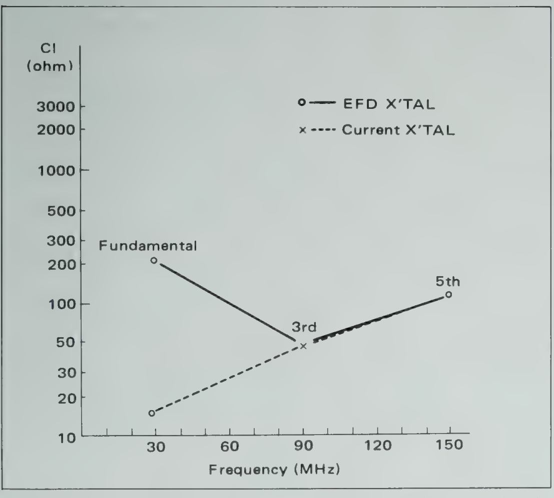


Fig. 13 Typical data of harmonic responce on EFD crystal units

(2) Example of a Circuit Used for the EFD Series Crystal Unit

Fig.14 shows an example of the type of circuit used for the EFD crystal. It can be easily recognized that, except for the expansion coil, the circuit is identical to the 10 MHz circuit described in Fig.8.

The expansion coil may also be omitted, if this is specifically requested by the users. It so, it is possible to develop an overtone oscillator that represents a completely coil-less circuit.

Fig.15 is a block diagram for a high-speed CPU clock generator. In this generator, the coil is completely absent.

(3) Particular Features of the EFD Series Crystal Unit

- Parasitic oscillation-free
- Ideal for low power consumption circuit development
- Adjustment-free
- Permits the development of a coil-less circuit
- Ideal for set miniaturization

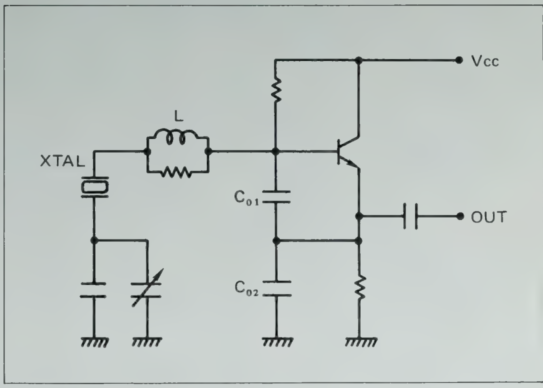


Fig. 14 Example of 1st local oscillator in the 90 MHz band using EFD series crystal units

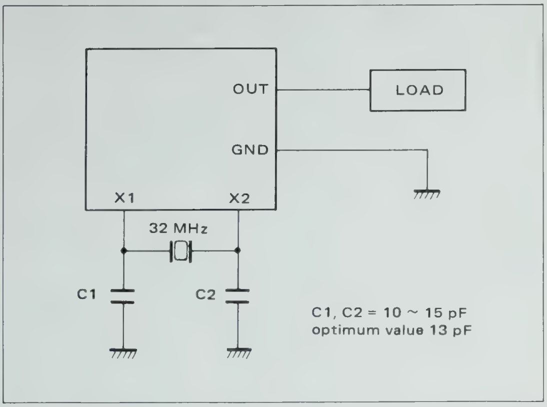


Fig. 15 Example of a high-speed CPU clock generator using an EFD series crystal unit

GUIDANCE AND DEFINITIONS

V. Determining Specifications and Submission of Inquiries

TOYOCOM has a long-standing record as an integrated quartz crystal manufacturer and is therefore in a position to offer a wide range of services on the basis of their extensive experience. We have established our own internal specifications to cover reliability aspects over and above the electrical performance features of these products. When addressing inquiries to TOYOCOM, please be sure to state the particular application purpose (for example, pager, portable telephone, etc.) along with the required performance data. This will allow us to supply the product that exactly corresponds to your needs.

(1) Inquiries and Orders

① Holder: Select from the TOYOCOM catalogue details the desired dimension sealing or retainer method

② Nominal Frequency: Nominal frequency or channel frequency and calculation formula for these

③ Mode of oscillation: Cut or mode description and order of overtone

④ Frequence tolerance: Manufacturing tolerance at reference temperature ±5 ppm is possible as an option.
Please state clearly if frequency shift is required

⑤ Equivalent resistance: Normally, the maximum value is specified

⑥ Load capacitance: Please state the design load capacitance
To enhance the accuracy even further, it is recommended to ask for a round-robbin procedure to be applied for sample crystal units

⑦ Frequency-temperature characteristics: Specify the temperature range or particular temperature along with the standard temperature/frequency change
Example: ±5 ppm over −10 to +60°C (referring to 25°C)

⑧ Drive level: Specify the operation level
This level essentially implies the power that is consumed by the crystal unit

⑨ Option: TOYOCOM offers the following options in an endeavor to provide crystal unit that are even easier to use

- Suitable for IR reflow process
- Metal jacket (page 28 in this catalogue) for easier surface mounting
- EFD series for circuit simplification and adjustment-free operation (see page 18, 19)
- Insulation pad for resistance-welded holder

⑩ Marking: TOYOCOM's standard marking will be supplied unless specifically requested otherwise

(2) Ordering Formula

The following page may be used as form for entering the examination results in response to the various items of section (1). Please make a copy for your use. For options and details regarding required markings, please enter where appropriate. A separate column has also been provided for applications. Please enter where appropriate.

Holder	
Nominal frequency	Hz
Mode of vibration	
Frequency tolerance (at 25 ± 3°C)	ppm
Load capacitance (C_L)	pF
Frequency stability in operating temperature range (refered to 25°C)	ppm
Operating temperature range	°C to °C
Resonance resistance (R_r)	Ω
Motional capacitance (C_1)	fF
Shunt capacitance (C_0)	pF
Drive level	mW
Other requirements, if any	

for 1st local oscillators in pager

HOLDER: UM-5, UM-4, UM-1

Features

- Excellent shock proof
- Excellent frequency aging characteristics
- Small deviation from the specified frequency pulling rage
- High frequency reproducibility

FREQUENCY RANGE : 30 to 175MHz
METHOD OF SEALING: Resistance Weld
MODE OF VIBRATION : AT-cut 3rd. 5th Thickness shear
LOAD CAPACITANCE : (S)
DRIVE LEVEL : 2μW

Frequency tolerance (at 25±3°C)

AA	A	B
±5ppm	±10ppm	±15ppm

Aging

AA	A	B
±1ppm/year	±2ppm/year	±4ppm/year

Resonance resistance (R_r)

Frequency	Mode	R_r	
		UM-5 UM-4	UM-1
30 to 90 MHz	3rd	60Ω	45Ω
60 to 150 MHz	5th	90Ω	60Ω

Frequency stability

(in operating temperature range referring 25°C)

		R	RS	S	T	V	W
		±3 ppm	±4 ppm	±5 ppm	±7.5 ppm	±10 ppm	±15 ppm
EE	0 to 45°C						
E	0 to 50°C						
F	−5 to 55°C						
FG	−10 to 50°C						
G	−10 to 60°C						
H	−15 to 65°C						
J	−20 to 70°C						

Our proposal in multiplication stage

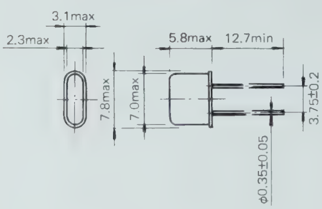
Antenna frequency (MHz)	Crystal frequency (MHz)	Multiplication order
40	40	Direct
150	75	x2
450	75	x2x3
900	75	x2x3x2

Outline drawing

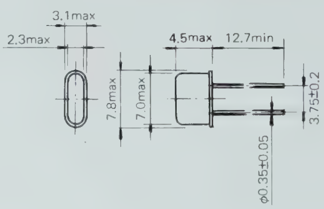
Size in mm

mm	inch
0.05	.002
0.2	.008
0.35	.014
2.3	.091
3.1	.122
3.75	148
4.5	.177
5.8	.228
7.0	.276
7.8	.307
12.7	.500

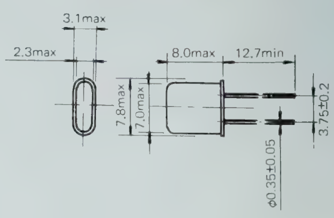
UM-5 (Resistance weld)



UM-4 (Resistance weld)



UM-1 (Resistance weld)



Crystal Units

TOYOCOM

for reference oscillators of frequency synthesizer and for both analog and digital TCXOs

Holder : HC-43/U, HC-49/U, UM-1, UM-2

Features

- Small deviation from the specified frequency pulling range
- Excellent reproducibility
- Excellent continuity for frequency-temperature characteristics
- Small deviation of inflection temperature

Frequency (MHz)

3.200	3.579545	3.600	3.84	4.096	4.800	5.120
6.400	–	7.200	7.68	8.192	9.600	10.240
12800	14.31818	14.400	15.36	–	–	–

Frequency tolerance (at 25±3°C)

AA	A	B
±5ppm	±10ppm	±15ppm

Aging

AA	A
±0.5ppm/year	±1ppm/year

Resonance resistance (R_r)

Frequency	HC-43/U	HC-49/U	UM-1	UM-2
3.2 to 4 MHz	150Ω max	–	–	–
4 to 5 MHz	70Ω	70Ω	–	–
5 to 7 MHz	60Ω	60Ω	–	–
7 to 10 MHz	30Ω	30Ω	–	–
More than 10 MHz	25Ω	25Ω	30Ω	30Ω

Frequency stability

(in operating temperature range referring 25°C)

		R	S	T	V	W	X	Y	Z
		±3 ppm	±5 ppm	±7.5 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C	■	■	■					
F	−5 to 55°C	■	■	■					
G	−10 to 60°C		■	■	■				
H	−15 to 65°C		■	■	■				
I	−20 to 70°C			■	■	■			
J	−25 to 75°C				■	■	■		
K	−30 to 80°C					■	■	■	
L	−40 to 90°C						■	■	■
M	−55 to 105°C							■	■

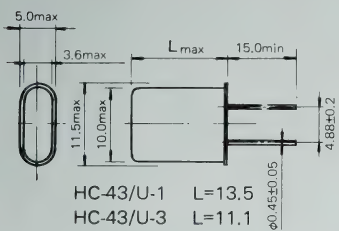
MODE OF VIBRATION : AT-cut, Fundamental
DRIVE LEVEL : 0.1mW max.
LOAD CAPACITANCE (C_L) : (S) or 20pF or 30pF

* For TCXO use, you can specify any preferaby 1st-order temperature coefficient at the inflection temperature.

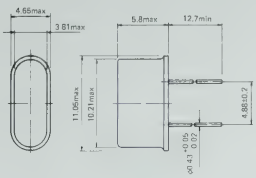
Outline drawing

Size in mm

HC-43/U (Cold weld)

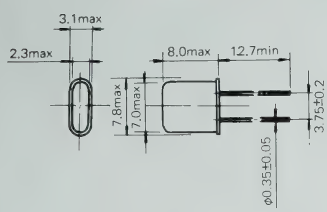


HC-49/U (Resistance weld)

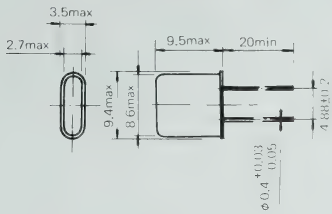


mm	inch
0.02	.0008
0.03	.0012
0.05	.002
0.2	.008
0.35	.014
0.4	.016
0.43	.017
0.45	.018
2.3	.091
2.7	.106
3.1	.122
3.5	.138
3.6	.142
3.81	.150
4.65	.183
4.88	.192
5.00	.197
5.8	.228
7.0	.276
7.8	.307
8.0	.315
8.6	.339
9.4	.370
9.5	.374
10.0	.394
10.21	.402
11.05	.435
11.5	.453
12.7	500
13 46	530
13 5	531
15.0	591
20.0	787

UM-1 (Resistance weld)



UM-2 (Resistance weld)



for 2nd local oscillators in VHF/UHF band radio communications

Holder HC-18/U, HC-43/U, HC-49/U

FREQUENCY 10.245MHz, 11.155MHz
APPLICATION 2nd local oscillator in conjunction with 10.7MHz IF

Frequency tolerance (at 25±3°C)

A	B	C	D
±10ppm	±15ppm	±20ppm	±30ppm

MODE OF VIBRATION AT-Cut , Fundamental

Frequency stability
(in operating temperature range referring 25°C)

		S	T	V	W	X	Y	Z
		±5 ppm	±7 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C							
F	−5 to 55°C							
G	−10 to 60°C							
H	−15 to 65°C							
J	−20 to 70°C							
K	−25 to 75°C							
L	−30 to 80°C							
M	−40 to 90°C							
N	−55 to 105°C							

Standard products

DRIVE LEVEL : 0.5±0.1mW
LOAD CAPACITANCE (C_L) : 30±0.3pF
RESONANCE RESISTANCE (R_r) : 40Ω max.
SHUNT CAPACITANCE (C_0) : 5.5pF max.

Holder UM-1, UM-2, UM-5, HC-43/U, HC-18/U. HC-49/U,

FREQUENCY 20.945MHz, 21.855MHz
APPLICATION 2nd local oscillator in conjunction with 21.4MHz IF

Frequency tolerance (at 25±3°C)

A	B	C	D
±10ppm	±15ppm	±20ppm	±30ppm

MODE OF VIBRATION AT-Cut , Fundamental

Frequency stability
(in operating temperature range referring 25°C)

		S	T	V	W	X	Y	Z
		±5 ppm	±7 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C							
F	−5 to 55°C							
G	−10 to 60°C							
H	−15 to 65°C							
J	−20 to 70°C							
K	−25 to 75°C							
L	−30 to 80°C							
M	−40 to 90°C							
N	−55 to 105°C							

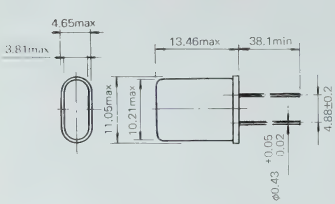
Standard products

DRIVE LEVEL : 0.5±0.1mW
LOAD CAPACITANCE (C_L) : 30±0.3pF
RESONANCE RESISTANCE (R_r) : 30Ω max.
SHUNT CAPACITANCE (C_0) : 5.5pF max.

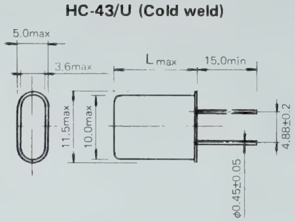
Outline drawing

Size in mm

HC-18/U (Solder seal)

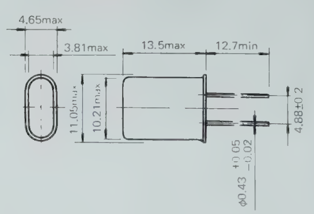


HC-43/U (Cold weld)



HC-43/U-1 L=13.5
HC-43/U-3 L-11.1

HC-49/U (Resistance weld)



mm	inch
0.02	.0008
0.05	.002
0.2	.008
0.43	.017
0.45	.018
3.60	.142
3.81	.150
4.65	.183
4.88	.192
5.0	.200
10.0	.394
10.21	.402
11.05	.435
11.5	.453
12.7	.500
13.46	.530
13.5	.531
15.0	.591
20.0	.787

for 2nd local oscillators in VHF/UHF band radio communications

Holder UM-1, UM-2, UM-5

FREQUENCY : 34.300 MHz, 44.545 MHz, 45.455 MHz, 54.545 MHz, 54.570 MHz, 57.6575 MHz, 59.300 MHz, 69.545 MHz
APPLICATION : 2nd local oscillator in conjunction with 45 MHz, 55 MHz and 70 MHz IF

Frequency tolerance (at 25±3°C)

A	B	C	D
±10ppm	±15ppm	±20ppm	±30ppm

MODE OF VIBRATION AT-Cut 3rd Overtone

Frequency stability
(in operating temperature range referring 25°C)

		S	T	V	W	X	Y	Z
		±5 ppm	±7 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C							
F	−5 to 55°C							
G	−10 to 60°C							
H	−15 to 65°C							
J	−20 to 70°C							
K	−25 to 75°C							
L	−30 to 80°C							
M	−40 to 90°C							
N	−55 to 105°C							

Standard products

DRIVE LEVEL : 0.5 ± 0.1mW
LOAD CAPACITANCE : Series Resonance
RESONANCE RESISTANCE (R_r) : 50Ω max. (60Ω max. for UM-5)
SHUNT CAPACITANCE (C_o) : 4.5pF max.

Holder UM-1, UM-2, UM-5

FREQUENCY : 79.300 MHz, 81.745 MHz, 89.545 MHz
APPLICATION : 2nd local oscillator in conjunction with 90 MHz IF

Frequency tolerance (at 25±3°C)

A	B	C	D
±10ppm	±15ppm	±20ppm	±30ppm

MODE OF VIBRATION AT-Cut 5th Overtone

Frequency stability
(in operating temperature range referring 25°C)

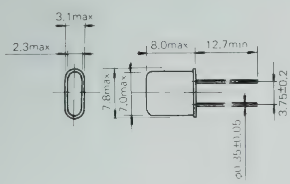
		S	T	V	W	X	Y	Z
		±5 ppm	±7 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C							
F	−5 to 55°C							
G	−10 to 60°C							
H	−15 to 65°C							
J	−20 to 70°C							
K	−25 to 75°C							
L	−30 to 80°C							
M	−40 to 90°C							
N	−55 to 105°C							

Standard products

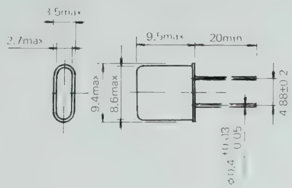
DRIVE LEVEL : 0.5 ± 0.1mW
LOAD CAPACITANCE : Series Resonance
RESONANCE RESISTANCE (R_r) : 70Ω max. (90Ω max. for UM-5)
SHUNT CAPACITANCE (C_o) : 4.5pF max.

Outline drawing
Size in mm

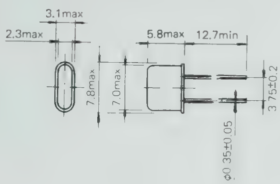
UM-1 (Resistance weld)



UM-2 (Resistance weld)



UM-5 (Resistance weld)



mm	inch
0.03	.0012
0.05	.002
0.2	.008
0.35	.014
0.40	.016
2.3	.091
2.7	.106
3.1	.122
3.5	.138
3.75	.148
6.0	.236
7.0	.276
7.8	.307
8.0	.315
8.6	.339
9.4	.371
9.5	.374
12.7	.500
20.0	.787

VCXOs IN TIMING RECOVERY AND FM MODULATOR

Holder: HC-43/U, HC-49/U, UM-1

Features

- Small deviation from the specified frequency pulling rage
- Phase zitter free
- Excellent distorsion characteristics
- Wide capture range

FREQUENCY RANGE :
METHOD OF SEALING:
MODE OF VIBRATION : AT-cut Fundamental, 3rd Thickness shear
LOAD CAPACITANCE : (S), 20pF, 30pF
DRIVE LEVEL : 0.5mW max.

Frequency tolerance (at 25±3°C)

A	B
±10ppm	±15ppm

Aging

A	B
±1ppm/year	±2ppm/year

Resonance resistance (R_r)

Frequency	Mode	R_r	
		HC-43/U HC-49/U	UM-1
3.2 to 4 MHz	Fund	150Ω max	–
4 to 5 MHz	Fund	70Ω	–
5 to 7 MHz	Fund	60Ω	–
7 to 10 MHz	Fund	30Ω	–
10 to 30 MHz	Fund	25Ω	30Ω
30 to 52 MHz	Fund	–	40Ω
30 to 100 MHz	3rd	40Ω	45Ω

Frequency stability

(in operating temperature range referring 25°C)

(Fundamental)		R	S	T	V	W	X	Y	Z
		±3 ppm	±5 ppm	±7.5 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C								
F	−5 to 55°C								
G	−10 to 60°C								
H	−15 to 65°C								
I	−20 to 70°C								
J	−25 to 75°C								
K	−30 to 80°C								
L	−40 to 90°C								
M	−55 to 105°C								

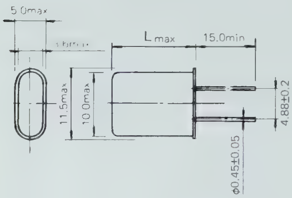
(3rd)		R	S	T	V	W	X	Y	Z
		±3 ppm	±5 ppm	±7.5 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C								
F	−5 to 55°C								
G	−10 to 60°C								
H	−15 to 65°C								
I	−20 to 70°C								
J	−25 to 75°C								
K	−30 to 80°C								
L	−40 to 90°C								
M	−55 to 105°C								

*For VCXO use, you can specify any preferably frequency-shift at nominal frequency.

Outline drawing

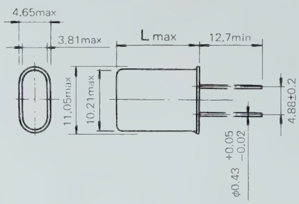
Size in mm

HC-43/U (Cold weld)



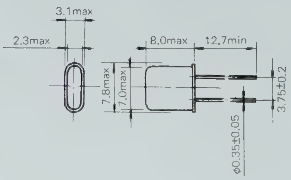
HC-43/U-1 L=13.5
HC-43/U-3 L=11.1

HC-49/U (Resistance weld)



HC-49/U-1 L=13.5
HC-49/U-3 L=11.1

UM-1 (Resistance weld)



mm	inch
0.02	.0008
0.05	.002
0.2	.008
0.35	.014
0.43	.017
0.45	.018
2.30	.091
3.10	.122
3.60	.142
3.75	.148
3.81	.150
4.65	.183
4.88	.192
5.00	.200
7.0	.276
7.8	.307
8.0	.315
10.0	.394
10.21	.402
11.05	.435
11.5	.453
12.7	.500
15.0	.591

ULTRA MINIATURE CRYSTAL UNIT

for tone squelch and for time reference of digital pagers

Feature
Ultra miniaturized holder

FREQUENCY : 455 kHz (Holder HC-43/U)
1000 kHz (Holder HC-43/U, UM-1)
1008 kHz (Holder HC-43/U, UM-1)

LOAD CAPACITANCE : (S)
MODE OF VIBRATION : SL-cut
DRIVE LEVEL : 0.5mW

Frequency tolerance

A	B	C
±100ppm	±200ppm	±3000ppm

for (A) and (B) measurement is made at 25°C±3°C, if special condition is not required.
for (C) overall tolerance

Resonance resistance (R_r)

Holder	R_r
HC-43/U	3kΩ max
UM-1	5kΩ

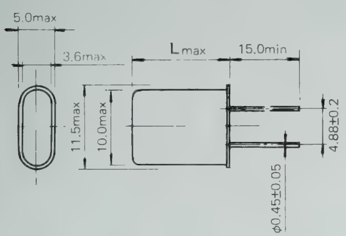
Frequency stability
(in operating temperature range referring 25°C for (A) and (B))

A	B	C
±100ppm(–10 to 50°C)	±300ppm(–10 to 60°C)	±3000ppm(–10 to 60°C)

for (C) overall tolerance

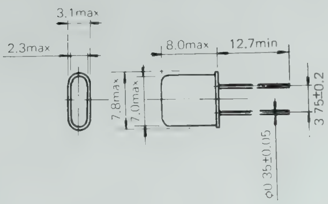
Outline drawing
Size in mm

HC-43/U (Cold weld)



HC-43/U-1 L=13.5
HC-43/U-3 L=11.1

UM-1 (Resistance weld)



mm	inch
0.005	.0002
0.2	.008
0.35	.014
0.45	.018
2.3	.091
3.1	.122
3.6	.142
3.75	.148
5.0	.197
7.0	.276
7.8	.307
8.0	.315
10.0	.394
11.1	.437
11.5	.453
12.7	.500
13.5	.531
15.0	.591

EFFECTIVE FUNDAMENTAL DESIGN SERIES

EFD

for 1st local (2nd local) oscillators in VHF/UHF band radio communications

Effective Fundamental design achieves an efficient AT-cut 3rd overtone mode crystal unit while maximizing suppression of its fundamental mode response to make oscillation circuits coil-less and the same as the fundamental mode

Features

- Adjustment-free — oscillation of the overtone frequency in tuning coil-less circuits
- Excellent shock-proof characteristics with the overtone mode
- Parasitic oscillation-free
- Maintainance-free

Frequency tolerance (at 25±3°C)

A	B	C	D
±10ppm	±15ppm	±20ppm	±30ppm

Aging

AA	A	B
±1ppm/year	±2ppm/year	±4ppm/year

Resonance resistance (R_r)

Frequency	UM-1	UM-5
30 to 40 MHz	80Ω max	–
40 to 100 MHz	60Ω	70Ω

Frequency stability

(in operating temperature range referring 25°C)

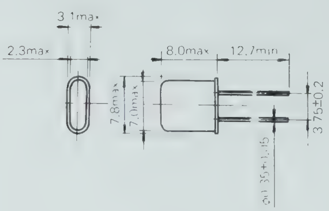
		R	RS	S	T	V	W
		±3 ppm	±4 ppm	±5 ppm	±7.5 ppm	±10 ppm	±15 ppm
EE	0 to 45°C						
E	0 to 50°C						
F	−5 to 55°C						
FG	−10 to 50°C						
G	−10 to 60°C						
H	−15 to 65°C						
J	−20 to 70°C						

HOLDER : UM-1, UM-5
FREQUENCY RANGE : 30MHz to 100MHz
MODE OF VIBRATION : AT-cut 3rd. Overtone EFD
LOAD CAPACITANCE : Series Resonance
DRIVE LEVEL : 2μW, 0.1mW, 0.5mW

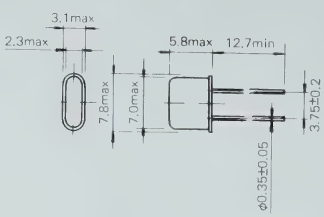
Outline drawing

Size in mm

UM-1 (Resistance weld)



UM-5 (Resistance weld)



mm	inch
0.03	.001
0.05	.002
0.2	.008
0.35	.014
0.4	.016
1.6	.063
2.3	.091
2.6	.102
2.7	.106
3.1	.122
3.5	.138
3.75	.148
4.88	.192
5.8	.228
7.0	.276
7.8	.307
8.0	.315
8.6	.339
9.4	.370
9.5	.374
12.7	.500
20.0	.787

EFFECTIVE FUNDAMENTAL DESIGN SERIES

EFD

for clock pullse generators/drivers and for gate array

Holder: HC-49/U

Features

- Oscillation in overtone frequency with coil-less circuit and adjustment-free
- Excellent shock-proof with the overtone mode
- Parastic oscillation-free
- Maintainance-free

FREQUENCY : 32.000 MHz
LOAD CAPACITANCE : (S), 10 pF
MODE OF VIBRATION : AT-cut 3rd Overtone EFD
DRIVE LEVEL : 0.5 ± 0.1 mW
SHUNT CAPACITANCE : 7 pF max.

Resonance resistance (R_r)

70Ω max

Remarks

Other frequencies and specifications are available on request.

Frequency tolerance (at 25±3 C)

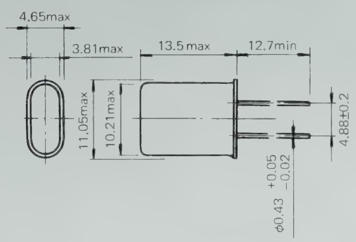
±50ppm

Frequency stability
(in operating temperature range refered to 25°C)

±50ppm (−10 to 70°C)

Outline drawing
Size in mm

HC-49/U (Resistance weld)



mm	inch
0.03	.001
0.05	.002
0.2	.008
0.35	.014
0.4	.016
1.6	.063
2.3	.091
2.6	.102
2.7	.106
3.1	.122
3.5	.138
3.75	.148
4.88	.192
7.0	.276
7.8	.307
8.0	.315
8.6	.339
9.4	.370
9.5	.374
12.7	.500
20.0	.787

ULTRA MINIATURE RESISTANCE WELD Holder: UM-5, UM-4

These crystal units are of ultra-miniaturized metal holder types introducing resistance weld sealing method.
Lead wire type terminals are provided.
This series has following features:
Shock-proved ultra-miniaturized holder
Excellent frequency aging characteristics
High frequency reproducibility
Small deviation from the specified frequency pulling range

FREQUENCY RANGE : 10MHz to 200MHz
METHOD OF SEALING : Resistance Weld
MODE OF VIBRATION : AT-cut
Fundamental, 3rd, 5th, 7th
Thickness-shear

LOAD CAPACITANCE : (S), 20pF, 30pF,
DRIVE LEVEL : 0.5mW, 1mW

Frequency tolerance (at 25±3°C)

A	B	C	D
±10ppm	±15ppm	±20ppm	±30ppm

Aging

AA	A	B
±1ppm/year	±2ppm/year	±4ppm/year

Resonance resistance (R_r)

Frequency	Mode	R_r
10 to 15 MHz	Fund	60Ω max
15 to 20 MHz	Fund	45Ω
20 to 30 MHz	Fund	30Ω
30 to 90 MHz	3rd	60Ω
60 to 150 MHz	5th	90Ω
90 to 200 MHz	7th	180Ω

Frequency stability
(in operating temperature range referring 25°C)

(Fundamental)		R	S	T	V	W	X	Y	Z
		±3 ppm	±5 ppm	±7.5 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C								
F	−5 to 55°C								
G	−10 to 60°C								
H	−15 to 65°C								
I	−20 to 70°C								
J	−25 to 75°C								
K	−30 to 80°C								
L	−40 to 90°C								
M	−55 to 105°C								

(3rd, 5th, 7th)		R	S	T	V	W	X	Y	Z
		±3 ppm	±5 ppm	±7.5 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C								
F	−5 to 55°C								
G	−10 to 60°C								
H	−15 to 65°C								
I	−20 to 70°C								
J	−25 to 75°C								
K	−30 to 80°C								
L	−40 to 90°C								
M	−55 to 105°C								

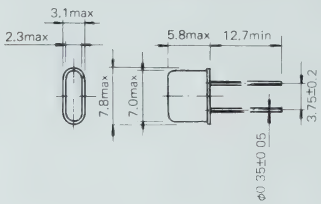
*High frequency fundamental crystals more than 30MHz are available in UM-5 on request.

Frequency: 30 to 52 MHz R_r: 40Ω max.

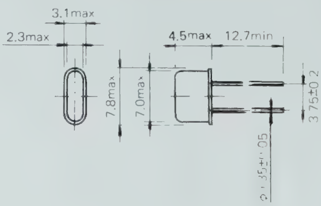
Outline drawing

Size in mm

UM-5 (Resistance weld)



UM-4 (Resistance weld)



mm	inch
0.05	.002
0.2	.008
0.35	.014
2.3	.091
3.1	.122
3.75	.148
4.5	.177
5.8	.228
7.0	.276
7.8	.307
12.7	.500

Crystal Units

TOYOCOM

ULTRA MINIATURE RESISTANCE WELD

Holder: UM-1 SLIM (Similar to HC-44/U), UM-1 (Similar to HC-80/U), UM-2

These crystal units are of ultra-miniaturized metal holder types introducing resistance weld sealing method.
Lead wire type terminals are provided.
This series has following features:
Ultra-miniaturized holder
Excellent frequency aging characteristics
High frequency reproducibility
Small deviation from the specified frequency pulling range

FREQUENCY RANGE : 10MHz to 200MHz
METHOD OF SEALING : Resistance Weld
MODE OF VIBRATION : AT-cut
Fundamental, 3rd, 5th, 7th
Thickness-shear
LOAD CAPACITANCE : (S), 20pF, 30pF,
DRIVE LEVEL : 0.5mW, 1mW, 2mW

Frequency tolerance (at 25±3°C)

A	B	C	D
±10ppm	±15ppm	±20ppm	±30ppm

Aging

AA	A	B
±1ppm/year	±2ppm/year	±4ppm/year

Resonance resistance (R_r)

Frequency	Mode	R_r
10 to 15 MHz	Fund	40 Ω max
15 to 30 MHz	Fund	25 Ω
25 to 30 MHz	3rd	50 Ω
30 to 90 MHz	3rd	45 Ω
50 to 150 MHz	5th	60Ω
90 to 200 MHz	7th	(90Ω)

Frequency stability
(in operating temperature range referring 25°C)

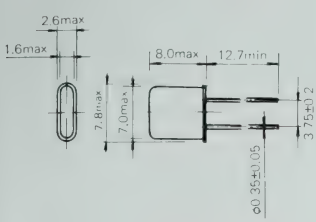
(Fundamental)		R	S	T	V	W	X	Y	Z
		±3 ppm	±5 ppm	±7.5 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C								
F	−5 to 55°C								
G	−10 to 60°C								
H	−15 to 65°C								
I	−20 to 70°C								
J	−25 to 75°C								
K	−30 to 80°C								
L	−40 to 90°C								
M	−55 to 105°C								

(3rd, 5th, 7th)		R	S	T	V	W	X	Y	Z
		±3 ppm	±5 ppm	±7.5 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C								
F	−5 to 55°C								
G	−10 to 60°C								
H	−15 to 65°C								
I	−20 to 70°C								
J	−25 to 75°C								
K	−30 to 80°C								
L	−40 to 90°C								
M	−55 to 105°C								

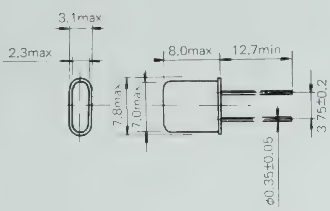
*High frequency fundamental crystals more than 30MHz are available in UM-1 on request.
Details are listed on page 16.

Outline drawing
Size in mm

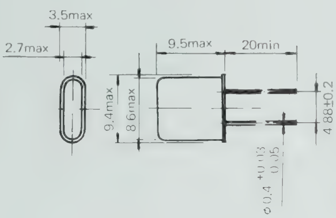
UM-1 SLIM (Resistance weld)



UM-1 (Resistance weld)



UM-2 (Resistance weld)



mm	inch
0.03	.001
0.05	.002
0.2	.008
0.35	.014
0.4	.016
1.6	.063
2.3	.091
2.6	.102
2.7	.106
3.1	.122
3.5	.138
3.75	.148
4.88	.192
7.0	.276
7.8	.307
8.0	.315
8.6	.339
9.4	.370
9.5	.374
12.7	.500
20.0	.787

MINIATURE RESISTANCE WELD Holder: HC-49/U, HC-43/RW

These crystal units are of miniaturized metal holder types introducing resistance weld sealing method.
Lead wire type terminals are provided.
This series has following features:
Excellent frequency aging characteristics
High frequency reproducibility
Small deviation from the specified frequency pulling range

FREQUENCY RANGE : 3.2MHz to 200MHz
METHOD OF SEALING : Resistance Weld
MODE OF VIBRATION : AT-cut
Fundamental, 3rd, 5th, 7th
Thickness-shear
LOAD CAPACITANCE : (S), 20pF, 30pF,
DRIVE LEVEL : 0.5mW, 1mW, 2mW

Frequency tolerance (at 25±3°C)

A	B	C	D
±10ppm	±15ppm	±20ppm	±30ppm

Aging

AA	A	B
±1ppm/year	±2ppm/year	±4ppm/year

Resonance resistance (R_r)

Frequency	Mode	Rr
3.2 to 4 MHz	Fund	150Ω max
4 to 5 MHz	Fund	70Ω
5 to 7 MHz	Fund	60Ω
7 to 10 MHz	Fund	30Ω
10 to 30 MHz	Fund	25Ω
20 to 25 MHz	3rd	45Ω
25 to 75 MHz	3rd	40Ω
75 to 90 MHz	3rd	45Ω
50 to 150 MHz	5th	60Ω
90 to 200 MHz	7th	90Ω

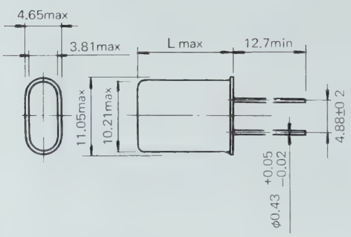
Frequency stability
(in operating temperature range referring 25°C)

(Fundamental)		R	S	T	V	W	X	Y	Z
		±3 ppm	±5 ppm	±7.5 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C								
F	−5 to 55°C								
G	−10 to 60°C								
H	−15 to 65°C								
I	−20 to 70°C								
J	−25 to 75°C								
K	−30 to 80°C								
L	−40 to 90°C								
M	−55 to 105°C								

(3rd, 5th, 7th)		R	S	T	V	W	X	Y	Z
		±3 ppm	±5 ppm	±7.5 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C								
F	−5 to 55°C								
G	−10 to 60°C								
H	−15 to 65°C								
I	−20 to 70°C								
J	−25 to 75°C								
K	−30 to 80°C								
L	−40 to 90°C								
M	−55 to 105°C								

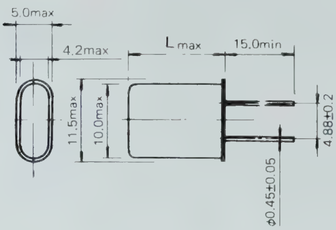
Outline drawing
Size in mm

HC-49/U (Resistance weld)



HC-49/U-1 L=13.5
HC-49/U-3 L=11.1

HC-43/RW (Resistance weld)



HC-43/RW-1 L=13.5
HC-43/RW-3 L=11.1

mm	inch
0.02	.0008
0.05	.002
0.2	.008
0.43	.017
0.50	.020
1.02	.040
3.81	.150
4.65	.183
4.88	.192
6.0	.236
10.21	.402
11.05	.435
12.7	.500
13.46	.530

HIGH STABILITY COLD WELD

Holder : HC-42/U, HC-43/U

These crystal units are of miniaturized metal holder type series introducing cold weld sealing method.
Pin type and lead wire type terminals are available.
This series has following features:
Excellent frequency aging characteristics
High frequency reproducibility
Small deviation from the specified frequency pulling range

FREQUENCY RANGE : 3.2MHz to 200MHz
METHOD OF SEALING : Cold Weld
MODE OF VIBRATION : AT-cut
Fundamental, 3rd, 5th, 7th
Thickness-shear
LOAD CAPACITANCE : (S), 20pF, 30pF,
DRIVE LEVEL : 0.5mW, 1mW, 2mW

Frequency tolerance (at 25±3°C)

A	B	C	D
±10ppm	±15ppm	±20ppm	±30ppm

Aging

A	B
±1ppm/year	±3ppm/year

Resonance resistance (R_r)

Frequency	Mode	R_r
3.2 to 4 MHz	Fund	150Ω max
4 to 5 MHz	Fund	70Ω
5 to 7 MHz	Fund	60Ω
7 to 10 MHz	Fund	30Ω
10 to 30 MHz	Fund	25Ω
20 to 25 MHz	3rd	45Ω
25 to 75 MHz	3rd	40Ω
75 to 90 MHz	3rd	45Ω
50 to 150 MHz	5th	60Ω
90 to 200 MHz	7th	90Ω

Frequency stability
(in operating temperature range referring 25°C)

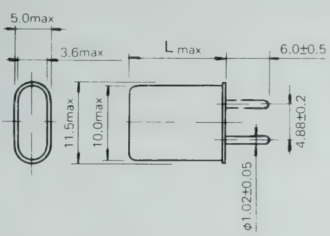
(Fundamental)		R	S	T	V	W	X	Y	Z
		±3 ppm	±5 ppm	±7.5 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C								
F	−5 to 55°C								
G	−10 to 60°C								
H	−15 to 65°C								
I	−20 to 70°C								
J	−25 to 75°C								
K	−30 to 80°C								
L	−40 to 90°C								
M	−55 to 105°C								

(3rd, 5th, 7th)		R	S	T	V	W	X	Y	Z
		±3 ppm	±5 ppm	±7.5 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C								
F	−5 to 55°C								
G	−10 to 60°C								
H	−15 to 65°C								
I	−20 to 70°C								
J	−25 to 75°C								
K	−30 to 80°C								
L	−40 to 90°C								
M	−55 to 105°C								

Outline drawing

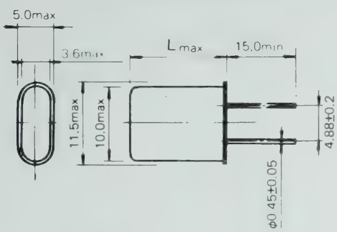
Size in mm

HC-42/U (Cold weld)



HC-42/U-1 L=13.5
HC-42/U-3 L=11.1

HC-43/U (Cold weld)



HC-43/U-1 L=13.5
HC-43/U-3 L=11.1

mm	inch
0.05	.002
0.2	.008
0.45	.018
1.02	.040
3.6	.142
4.88	.192
5.0	.197
6.0	.236
10.0	.394
11.1	.437
11.5	.453
13.5	.531
15.0	.591

HIGH STABILITY COLD WELD

Holder : HC-36/U, HC-47/U

These crystal units are of metal holder type series introducing cold weld sealing method.
Pin type and lead wire type terminals are available.
This series has following features:
Excellent frequency aging characteristics
High frequency reproducibility
Small deviation from the specified frequency pulling range

FREQUENCY RANGE : 2MHz to 15MHz
METHOD OF SEALING : Cold Weld
MODE OF VIBRATION : AT-cut
Fundamental
Thickness-shear
LAOD CAPACITANCE : (S), 20pF, 30pF,
DRIVE LEVEL
0.8 to 3MHz : 1mW, 2mW, 5mW
3 to 15MHz : 0.5mW, 1mW, 2mW

Frequency tolerance (at 25±3°C)

A	B	C	D
±10ppm	±15ppm	±20ppm	±30ppm

Aging

A	B
±1ppm	±3ppm/year

Resonance resistance (R_r)

Frequency	Mode	R_r
2 to 3 MHz	Fund	250Ω max
3 to 5 MHz	Fund	110Ω
5 to 7 MHz	Fund	50Ω
7 to 10 MHz	Fund	25Ω
10 to 15 MHz	Fund	20Ω

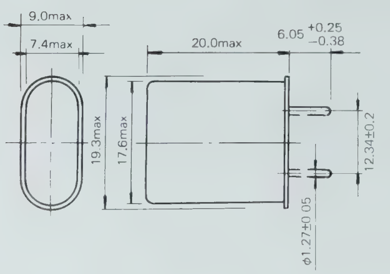
Frequency stability
(in operating temperature range referring 25°C)

2 to 3MHz		R	S	T	V	W	X	Y	Z
		±3 ppm	±5 ppm	±7.5 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C								
F	−5 to 55°C								
G	−10 to 60°C								
H	−15 to 65°C								
I	−20 to 70°C								
J	−25 to 75°C								
K	−30 to 80°C								
L	−40 to 90°C								
M	−55 to 105°C								

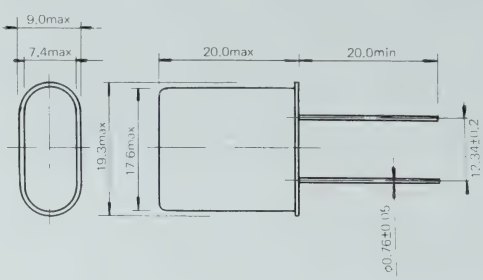
3 to 15MHz		R	S	T	V	W	X	Y	Z
		±3 ppm	±5 ppm	±7.5 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C								
F	−5 to 55°C								
G	−10 to 60°C								
H	−15 to 65°C								
I	−20 to 70°C								
J	−25 to 75°C								
K	−30 to 80°C								
L	−40 to 90°C								
M	−55 to 105°C								

Outline drawing
Size in mm

HC-36/U (Cold weld)



HC-47/U (Cold weld)



mm	inch
0.05	.002
0.2	.008
0.25	.010
0.38	.015
0.76	.030
1.27	.050
6.05	.238
7.4	.291
9.0	.354
12.34	.486
17.6	.693
19.3	.560
20.0	.787

SOLDER SEAL Holder : HC-6/U, HC-33/U

FREQUENCY RANGE : 0.8MHz to 15MHz
METHOD OF SEALING : Soldering Seal
MODE OF VIBRATION : AT-cut
Fundamental
Thickness-shear
LOAD CAPACITANCE : (S), 20pF, 30pF,
DRIVE LEVEL
0.8 to 3MHz : 1mW, 2mW, 5mW
3 to 15MHz : 0.5mW, 1mW, 2mW

Frequency tolerance (at 25±3°C)

A	B	C	D
±10ppm	±15ppm	±20ppm	±30ppm

Aging

A	B
±4ppm/year	±6ppm/year

Resonance resistance (R_r)

Frequency	Mode	R_r
0.8 to 1 MHz	Fund	800Ω max
1 to 1.5 MHz	Fund	600Ω
1.5 to 2 MHz	Fund	400Ω
2 to 3 MHz	Fund	250Ω
3 to 4 MHz	Fund	110Ω
4 to 5 MHz	Fund	70Ω
5 to 7 MHz	Fund	50Ω
7 to 10 MHz	Fund	25Ω
10 to 15 MHz	Fund	20Ω

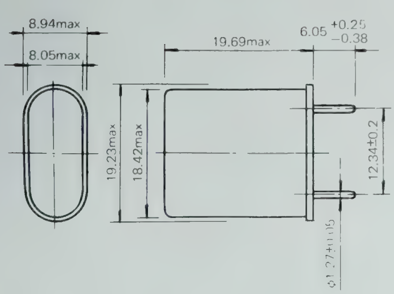
Frequency stability
(in operating temperature range referring 25°C)

0.8 to 3 MHz		R	S	T	V	W	X	Y	Z
		±3 ppm	±5 ppm	±7.5 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C								
F	−5 to 55°C								
G	−10 to 60°C								
H	−15 to 65°C								
I	−20 to 70°C								
J	−25 to 75°C								
K	−30 to 80°C								
L	−40 to 90°C								
M	−55 to 105°C								

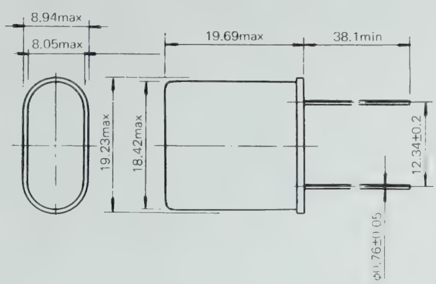
3 to 15 MHz		R	S	T	V	W	X	Y	Z
		±3 ppm	±5 ppm	±7.5 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C								
F	−5 to 55°C								
G	−10 to 60°C								
H	−15 to 65°C								
I	−20 to 70°C								
J	−25 to 75°C								
K	−30 to 80°C								
L	−40 to 90°C								
M	−55 to 105°C								

Outline drawing
Size in mm

HC-6/U (Solder Seal)



HC-33/U (Solder Seal)



mm	inch
0.05	.002
0.2	.008
0.25	.010
0.38	.015
0.76	.030
1.27	.050
6.05	.238
8.05	.317
8.94	.352
12.34	.486
18.42	.725
19.23	.757
19.69	.775
38.1	1.106

Crystal Units

TOYOCOM

SOLDER SEAL Holder : HC-6/U, HC-33/U

FREQUENCY RANGE : 180kHz to 750kHz
METHOD OF SEALING : Solder Seal
MODE OF VIBRATION : Fundamental
: 180kHz to 350kHz DT-out
: 300kHz to 750kHz CT-out
LOAD CAPACITANCE : (S), 30pF
DRIVE LEVEL : 0.5mW, 1mW

Frequency stability
(in operating temperature range referring 25°C)

		H	I	J	K	L	M	N	P
		±50 ppm	±60 ppm	±70 ppm	±100 ppm	±120 ppm	±150 ppm	±170 ppm	±200 ppm
C	0 to 50°C								
D	−5 to 55°C								
E	−10 to 60°C								
F	−15 to 65°C								
G	−20 to 70°C								

Frequency tolerance (at 25±3°C)

A	B
±15ppm	±25ppm

Aging

A	B
±4ppm/year	±6ppm/year

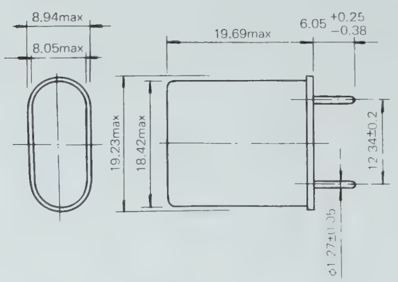
Resonance resistance (R_r)

Frequency	R_r
180 to 250 kHz	2 kΩ max
250 to 300 kHz	3.5 kΩ
300 to 350 kHz	1.8 kΩ
350 to 450 kHz	2.1 kΩ
450 to 550 kHz	2.5 kΩ
550 to 600 kHz	3 kΩ
600 to 700 kHz	4 kΩ
700 to 750 kHz	5 kΩ

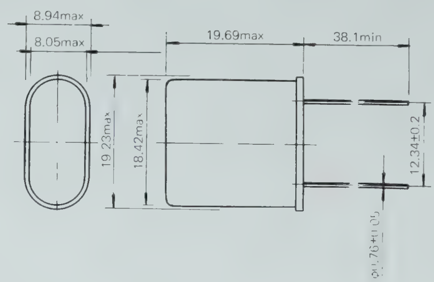
Outline drawing

Size in mm

HC-6/U (Solder Seal)



HC-33/U (Solder Seal)



mm	inch
0.05	.002
0.2	.008
0.25	.010
0.38	.015
0.76	.030
1.27	.050
6.05	.238
8.05	.317
8.94	.352
12.34	.486
18.42	.725
19.23	.757
19.69	.775
38.1	1.106

GLASS SEAL Holder : MT-N, RMT-N, SMT-N

These crystal units are encapsulated in the small glass tube. Lead wire type terminals are provided.

FREQUENCY RANGE : 2kHz to 180kHz
METHOD OF SEALING : Glass Seal
MODE OF VIBRATION : Fundamental
NT-cut, X-cut
LOAD CAPACITANCE : (S), 30pF, 60pF, 100pF,

Frequency tolerance (at 25±3°C)

Frequency	Mode	A	B
2 to 21 kHz	XY	±20 ppm	±30 ppm
21 to 85 kHz	NT	±20 ppm	±30 ppm
50 to 180 kHz	X	±15 ppm	±25 ppm

Drive level

Frequency	Mode	A	B
2 to 21 kHz	XY	0.05 mW	–
21 to 55 kHz	NT	0.05 mW	–
50 to 180 kHz	X	1 mW	0.5 mW

Aging

A	B
±5ppm/year	±7ppm/year

Resonance resistance (R_r)

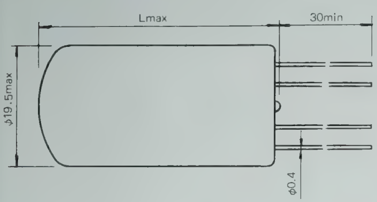
Frequency	R_r	Frequency	R_r
2 to 2.5 kHz	–	12 to 16 kHz	15kΩ max
2.5 to 3 kHz	–	16 to 21 kHz	10kΩ
3 to 3.5 kHz	85 kΩ max	21 to 25 kHz	15kΩ
3.5 to 4 kHz	75 kΩ	25 to 35 kHz	10kΩ
4 to 6 kHz	60 kΩ	35 to 50 kHz	7kΩ
5 to 6 kHz	45 kΩ	50 to 70 kHz	0.6kΩ
6 to 8 kHz	30 kΩ	70 to 80 kHz	0.8kΩ
8 to 9 kHz	25 kΩ	80 to 100 kHz	0.8kΩ
9 to 12 kHz	20 kΩ	100 to 180 kHz	0.9kΩ

Frequency stability
(in operating temperature range referring 25°C)

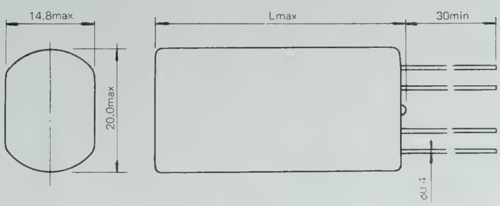
		H	I	J	K	L	M	N	P
		±50 ppm	±60 ppm	±70 ppm	±100 ppm	±120 ppm	±150 ppm	±170 ppm	±200 ppm
C	0 to 50°C								
D	–5 to 55°C								
E	–10 to 60°C								
F	–15 to 65°C								
G	–20 to 70°C								

Outline drawing
Size in mm

MT-N (Glass Seal)

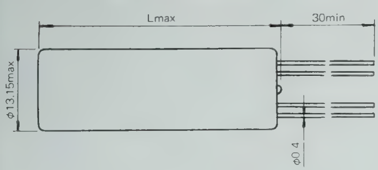


RMT-N (Glass Seal)



mm	inch
0.4	.016
13.15	.518
14.8	.583
19.5	.768
20.0	.787
30	1.181
40	1.575
90	3.543

SMT-N (Glass Seal)



L=40-90

ULTRA MINIATURE RESISTANCE WELD WITH METAL JACKET

Holder: UM-1 with metal jacket

Feature

- Available to Surface Mount Technology
- Available to IR-reflow process
- All Characteristics are same to UM-1

FREQUENCY RANGE : 10MHz to 200MHz
METHOD OF SEALING: Resistance Weld
MODE OF VIBRATION : AT-cut
Fundamental, 3rd, 5th, 7th
Thickness shear
LOAD CAPACITANCE : (S)20pF, 30pF,
DRIVE LEVEL : 0.5mW, 1mW, 2mW

Frequency tolerance (at 25±3°C)

A	B	C	D
±10ppm	±15ppm	±20ppm	±30ppm

Aging

AA	A	B
±1ppm/year	±2ppm/year	±4ppm/year

Resonance resistance (R_r)

Frequency	Mode	R_r
10 to 15 MHz	Fund	40 Ω max
15 to 30 MHz	Fund	25 Ω
25 to 30 MHz	3rd	50 Ω
30 to 90 MHz	3rd	45 Ω
50 to 150 MHz	5th	60Ω
90 to 200 MHz	7th	(90Ω)

Frequency stability
(in operating temperature range referring 25°C)

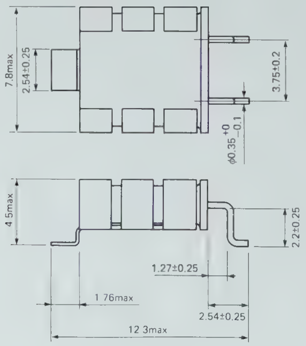
(Fundamental)		R	S	T	V	W	X	Y	Z
		±3 ppm	±5 ppm	±7.5 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C								
F	−5 to 55°C								
G	−10 to 60°C								
H	−15 to 65°C								
I	−20 to 70°C								
J	−25 to 75°C								
K	−30 to 80°C								
L	−40 to 90°C								
M	−55 to 105°C								

(3rd, 5th, 7th)		R	S	T	V	W	X	Y	Z
		±3 ppm	±5 ppm	±7.5 ppm	±10 ppm	±15 ppm	±20 ppm	±30 ppm	±50 ppm
E	0 to 50°C								
F	−5 to 55°C								
G	−10 to 60°C								
H	−15 to 65°C								
I	−20 to 70°C								
J	−25 to 75°C								
K	−30 to 80°C								
L	−40 to 90°C								
M	−55 to 105°C								

*High frequency fundamental crystals in UM-1 are available on request. Details are listed on page 16.

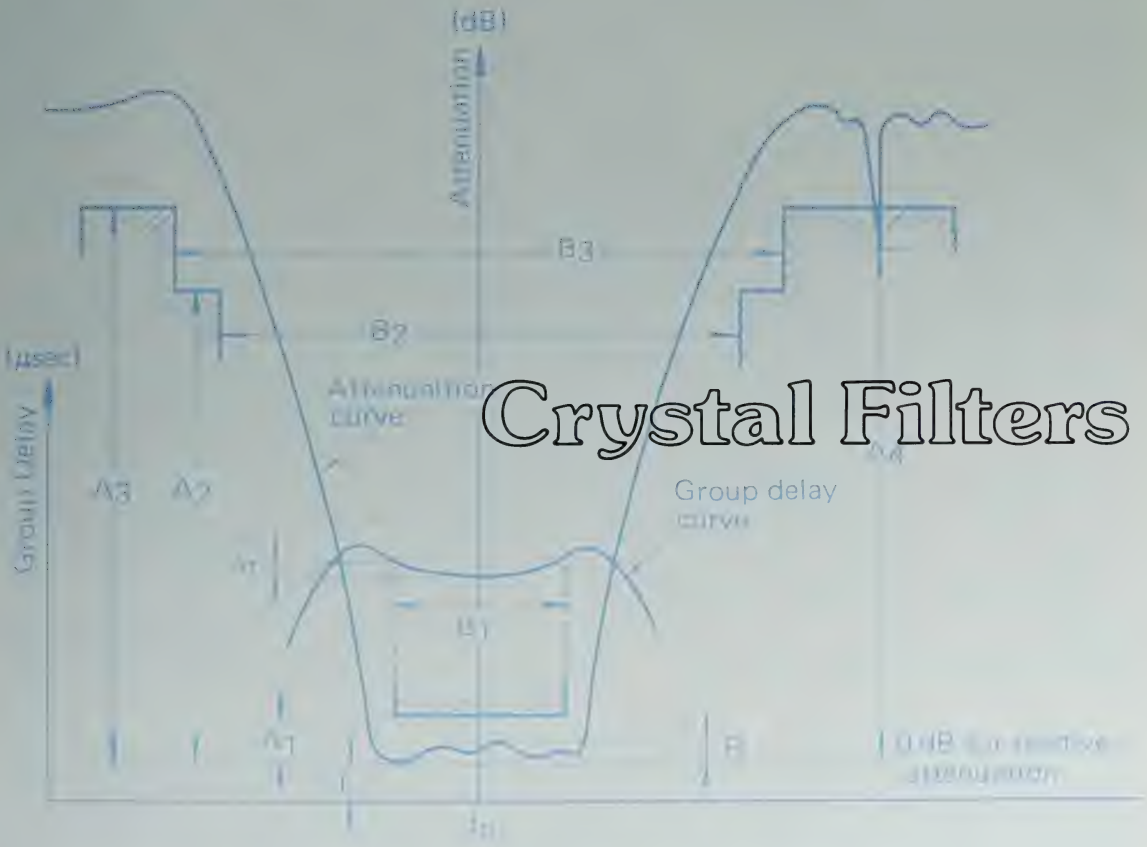
Outline drawing

Size in mm



mm	inch
0.1	.004
0.2	.008
0.25	.01
0.35	.014
1.27	.05
1.76	.069
2.2	.081
2.54	.100
3.75	.148
4.5	.177
7.8	.307
12.3	.484

Crystal Filters



CRYSTAL FILTERS

1. Outline of TOYOCOM CRYSTAL FILTERS

1. 1 Conventional Crystal Filters

TOYOCOM manufactures crystal filters with frequency ranges of between several kHz and 300 MHz, and bandwidths of between 0.001% and 2%, for a broad range of applications such as:

- Radio communications equipment
- Transmission communications equipment
- Microwave and coaxial cable system equipment
- Satellite communications equipment
- Avionics and marine radio equipment
- Measuring equipment
- PCM multiplex system equipment

Of these filters, those which use the AT-cut thickness shear mode crystal resonators, shown in Fig. 1, have been developed in a series of products well known for their advanced design and high quality, and having the features shown in Table 1. Among the features they share in common are the following:

Sharp selectivity: Extremely sharp selectivity has been achieved through attenuation pole design technique. The SSB filter series is a typical example.

Small insertion loss: Small insertion loss has been achieved by using high Q crystal resonators, built with our own high quality synthetic quartz, and low-loss transformers.

Linear phase filter: Linear phase filter has been developed with unique TOYOCOM design, combining the best characteristics of Gaussian type flat group delay and Chebyshev type sharp selectivity. These filters are suitable for the demand for digital mobile communications equipment.

Pilot filter: It is bound for PCM multiplex system. To meet an increasing need in the LAN market, we newly developed a small-sized and high-performance pilot filter for timing recovery.

1. 2 HCM filter (Tandem monolithic crystal filter)

The HCM filter, a TOYOCOM original, has the following features. A large number of these filters are in use as IF filter for mobile radio communications equipment. We developed the following series and diversified our range to respond to needs for miniaturization, non-adjustment, cost-reduction for the mobile radio communications equipment.

- TQF-880 series: With HCM resonators (45 MHz = fundamental mode, 70 through 95 MHz = 3rd overtone mode), the characteristics of linear phase are obtained with the small packages (T-2: 3.5 cc, S-428: 1.8 cc)
- Fundamental mode 45 MHz series and VHF series: These series have been developed mainly for the UHF cellular system and are very suitable to miniaturize the equipment and eliminate its adjustment.
- Ultra-miniature UM-5 series: This is a fundamental 2-pole HCM filter series specially for VHF low-band paging system and with a low profile type (height = 6 mm) a very high image rejection (60 dB) can be obtainable.

Compact design: The H-type series and UM-1 holder developed by TOYOCOM are recognized as the IEC Standard holders and are suitable to reduction of equipment size.

High reliability: Shock-proof and aging characteristics have been improved through the use of a special resistance welded holder. In particular the UM-1 and VHF series are widely used in paging receivers and UHF band mobile telephone equipment.

Excellent intermodulation characteristics: Abundant design experience and expert manufacturing knowhow of the coupled resonators have achieved excellent intermodulation characteristics.

Various standard products at low cost: TOYOCOM has prepared various kinds of standard HCM filters with the channel spacing between 12.5 kHz and 50 kHz at low cost.

Table 1. Applications of TOYOCOM crystal filters and HCM filters

Series	Type of filter	Frequency range (MHz)	No. of pole	Type of design		Applications				
						IF filter			Pilot filter	Others
				Chebyshev	Linear phase	Mobile telephone	Cordless telephone	Paging receiver		
TQF-800	Crystal filter	10.7 to 90	2 to 8		○	○				○
TQF-880	HCM filter	45, 70 to 95	4		○	○				○
10.7 MHz series	HCM filter	10.7	2 to 10	○						○
21.4 MHz series	HCM filter	21.4	2 to 10	○						○
45 MHz series	HCM filter	45 (Funda.)	2 to 8	○		○				○
		45 (3rd)	2 to 4	○		○	○			○
VHF element series	HCM filter	50 to 90	2 to 4	○		○	○			○
TQF-600	HCM filter	70 to 100	4	○		○				○
UM-5 series	HCM filter	21.4 to 50	2	○				○		
TQF-491	Crystal filter	30 to 150	2	○					○	

CRYSTAL FILTERS

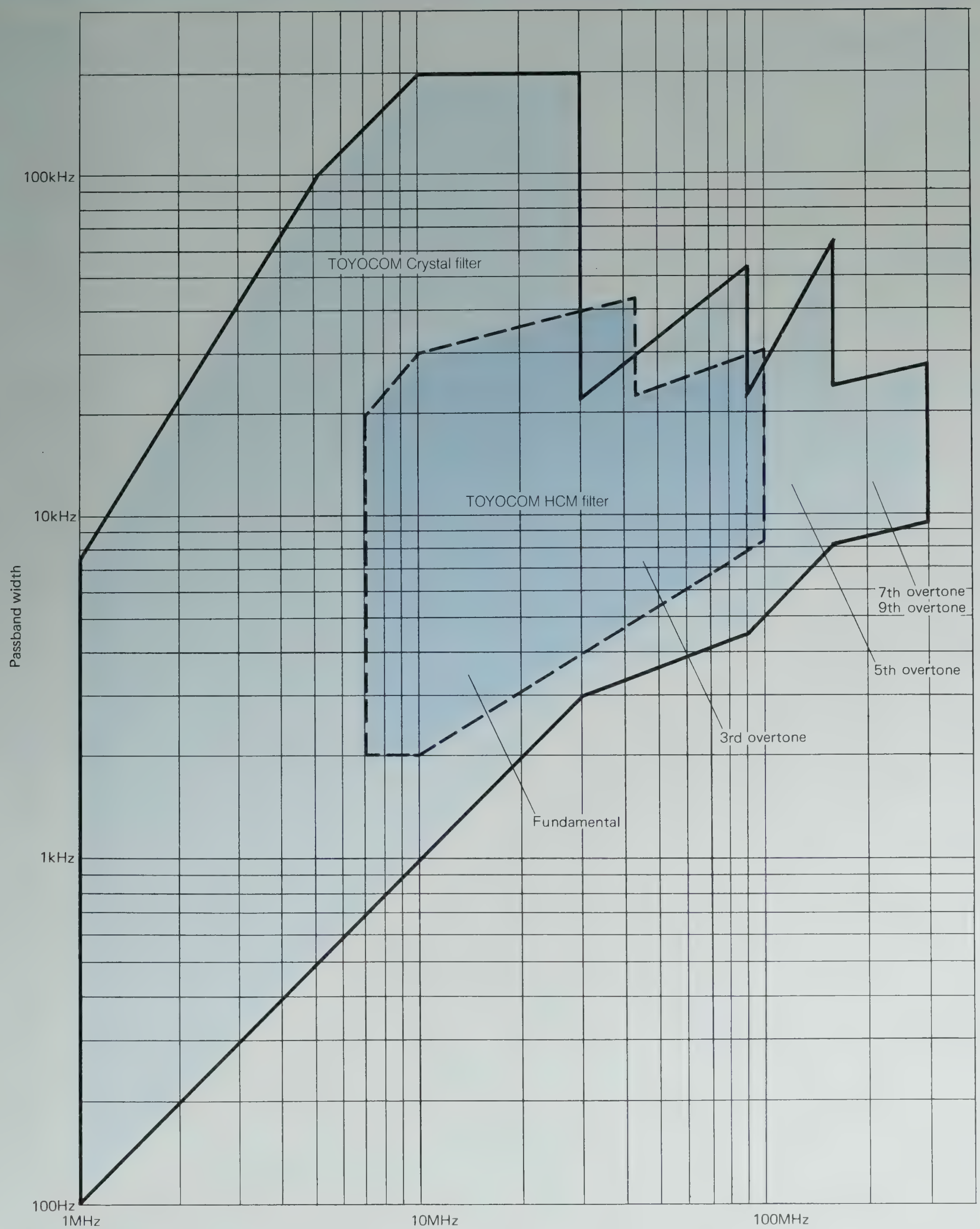
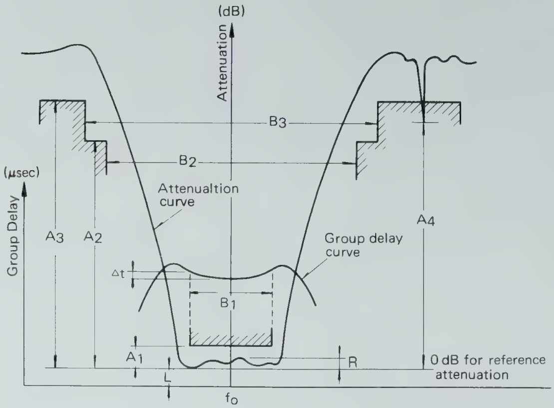


Fig. 1 Availability of TOYOCOM crystal filters (thickness shear mode)

CRYSTAL FILTERS

Terms and definitions

Term	Reference symbol	
Center frequency	fo (MHz) or (kHz)	A frequency given in the specification, to which other frequencies may be referred.
Passband	B1 (kHz) A1 (dB)	A band of frequencies B1 in which the attenuation is equal to or less than a specified value A1.
Stopband	B2 (kHz) A2 (dB) and B2 (kHz) A3 (dB)	Bands of frequencies B2 and B3 in which the attenuations are equal to or greater than specified values A2 and A3 respectively.
Insertion loss	L (dB)	The logarithmic ratio of the power delivered to the load impedance before insertion of the filter to the power delivered to the load impedance after insertion of the filter.
(Passband) Ripple	R (dB)	The difference between the maximum and minimum attenuations within a passband.
Guaranteed attenuation	A3 (dB)	The maximal guaranteed attenuation at the specified frequency range.
Spurious response	A4 (dB)	Minimum attenuation caused by extraordinary response in the stopband. Spurious response usually appears at a higher frequency than the center frequency.
Group delay distortion	Δt (μsec)	The difference between the maximum and minimum group delay within a passband B1 unless otherwise specified.
Terminating impedance	Zt Rt//Ct (Ω//pF)	Either of the impedances presented to the filter by the source or by the load, and described the resistive portion (Rt) and the parallel capacitive portion (Ct) including stray capacitance.



CRYSTAL FILTERS

Test circuit (Block Type)

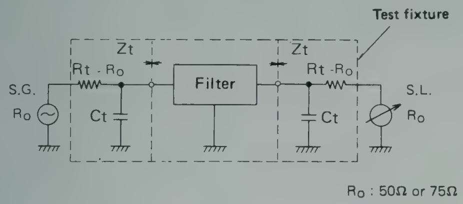


Fig. 2 Attenuation measurement

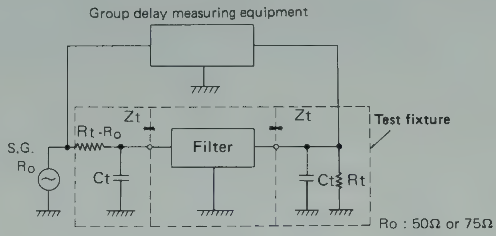
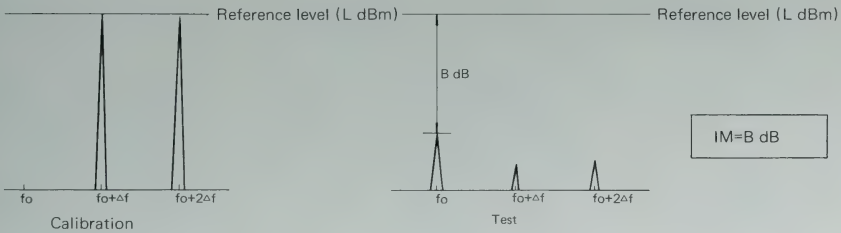


Fig. 3 Group delay measurement



or $\boxed{IM = B}$ (dB) at Input level of point A (Pin)

$\boxed{Ip = Pin + \frac{1}{2} B}$ (dBm)

Note: .Ip: Intercept point

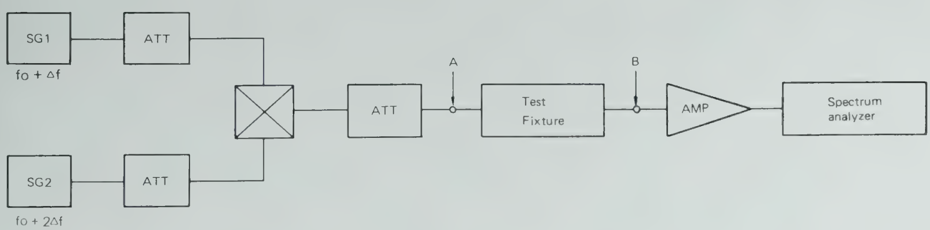
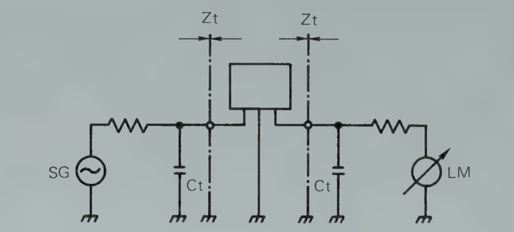


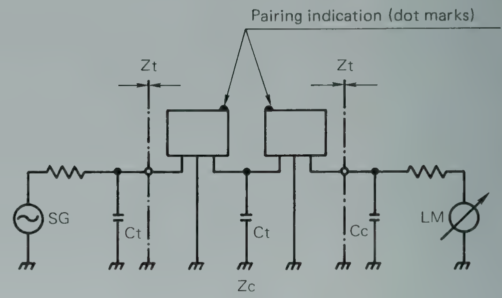
Fig. 4 Intermodulation measurement

HCM RESONATORS

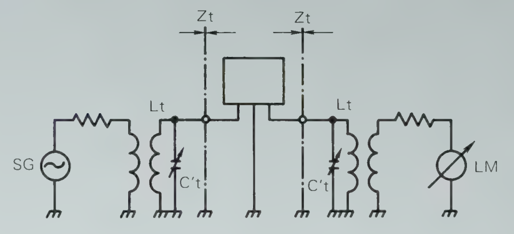
Test circuit (HCM Resonator Type)



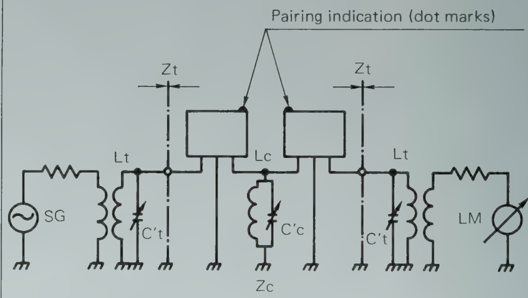
2-pole HCM filter



4-pole HCM filter



2-pole HCM filter



4-pole HCM filter

Terminating impedance: Zt = Rt (Ω)//Ct ± α (pF)
Coupling impedance: Zc = Cc ± α (pF)

$\text{Lt, Lc} \gg \frac{\text{Rt}}{Q\omega_0}$ Q: unloaded Q of coil

$\text{Lt, Lc} \geqq \frac{\text{Rt}}{10\omega_0}$ ω_0: $2\pi f_0$

$C't = \frac{1}{W_0^2 Lt} + Ct, \quad C'c = \frac{1}{W_0^2 Lc} + Cc$

HCM FILTERS VHF BLOCK TYPE FILTERS

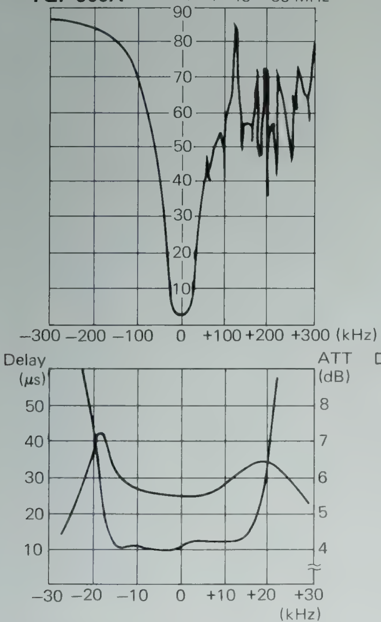
Type	Center frequency	No. of pole	Passband		Stopband				Max. loss	Group delay distortion		Terminating impedance	*Intermodulation test parameters Input level	ΔF	Case
	(MHz)		(dB)	(kHz)	(dB)	(kHz)	(dB)	(kHz)	(dB)	(μs)	(kHz)	Zt (Ω)	(dBm)	(kHz)	
TQF-600A	70 to 100	4	3	±15	20	±60	75	–910	6	10	±10	50	–15	60	**S-428
TQF-603A	70 to 100	4	3	±15	20	±60	75	–910	6	10	±10	50	–15	60	T-2
TQF-600B	70 to 100	4	3	±12	20	±50	75	–910	6	12	±8	50	–15	50	**S-428
TQF-603B	70 to 100	4	3	±12	20	±50	75	–910	6	12	±8	50	–15	50	T-2
TQF-600C	70 to 100	4	3	±10	20	±25	75	–910	6	15	±6	50	–20	25	**S-428
TQF-603C	70 to 100	4	3	±10	20	±25	75	–910	6	15	±6	50	–20	25	T-2
TQF-600D	70 to 100	4	3	±7.5	30	±25	75	–910	6	–		50	–20	25	**S-428
TQF-603D	70 to 100	4	3	±7.5	30	±25	75	–910	6	–		50	–20	25	T-2

*3rd order IM products (fo) –95 dBm max. **Non-washable

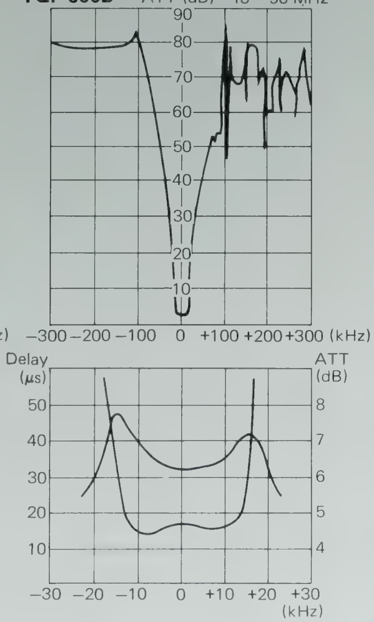
Operating temperature range: –30° C to +80° C

Electrical data

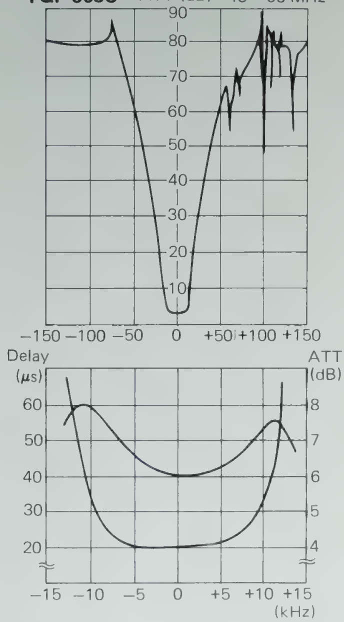
TQF-600A



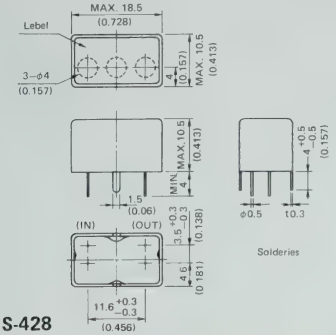
TQF-600B



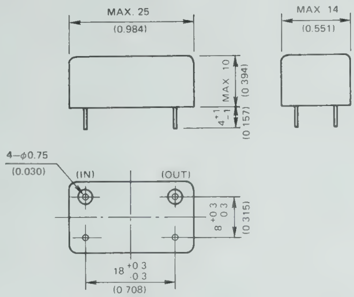
TQF-603C



Outline drawing



S-428



T-2

HCM FILTERS

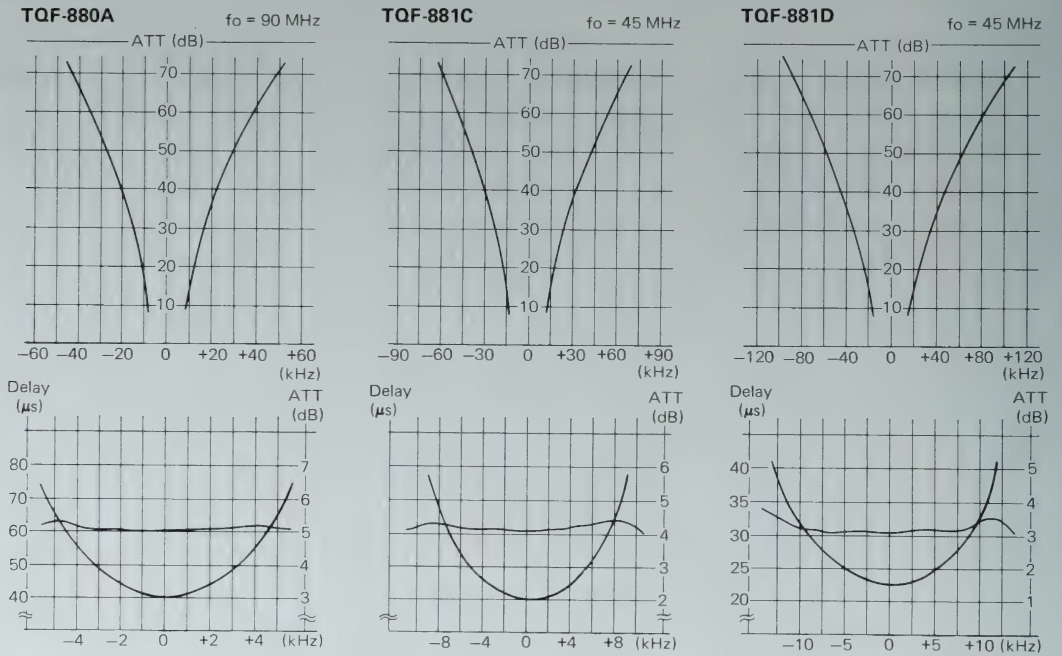
VHF LINEAR PHASE HCM FILTERS

Type	Center frequency (MHz)	No. of pole	Passband		Stopband				Max. loss (dB)	Group delay distortion (μs)	Terminating impedance Zt (Ω)	Case
			(dB)	(kHz)	(dB)	(kHz)	(dB)	(kHz)				
TQF-880A	70 to 95	4	3	±4.5	15	±12.5	75	–910	5	10	50	T-2
TQF-881A	70 to 95	4	3	±4.5	15	±12.5	75	–910	5	10	50	*S-428
TQF-880B	45	4	3	±4.5	15	±12.5	75	–910	5	10	50	T-2
TQF-881B	45	4	3	±4.5	15	±12.5	75	–910	5	10	50	*S-428
TQF-880C	45	4	3	±7.5	20	±25	75	–910	4	7	50	T-2
TQF-881C	45	4	3	±7.5	20	±25	75	–910	4	7	50	*S-428
TQF-880D	45	4	3	±10	15	±25	75	–910	4	5	50	T-2
TQF-881D	45	4	3	±10	15	±25	75	–910	4	5	50	*S-428

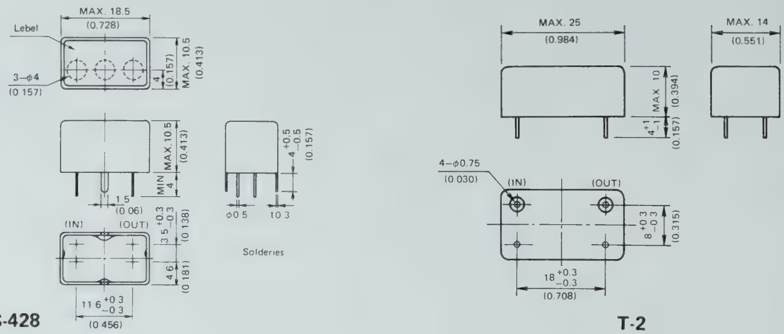
*Non-washable

Operating temperature range: –20°C to +70°C

Electrical data



Outline drawing



S-428

T-2

HCM FILTERS

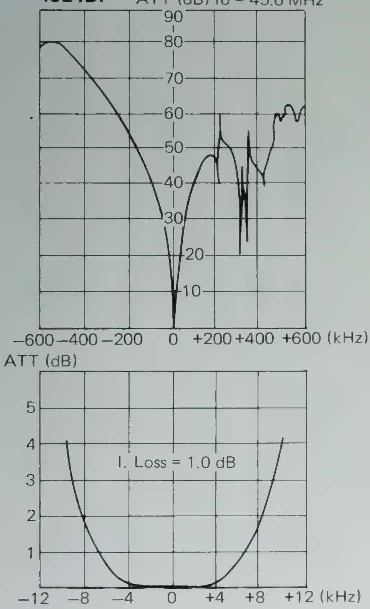
VHF 45MHz FUNDAMENTAL Mode Series
12.5KHz, 25KHz CHANNEL SPACING

Type	No. of pole	Passband		Stopband		Max. ripple	Max. loss	Guaranteed attenuation		Terminating impedance	Coupling impedance	Case
		(dB)	(kHz)	(dB)	(kHz)	(dB)	(dB)	(dB)	(kHz)	Zt (Ω//pF)	Zc (pF)	
45E1FF	2	3	±3.75	10	±12.5	1.0	2.0	65	–910	200//4	–	UM-1
45E2FF	4	3	±3.75	30	±12.5	1.0	4.0	90	±910	350//6.5	18	(UM-1) x 2
45E3FF	6	3	±3.75	50	±12.5	2.0	6.0	80	±910	350//5	–	H-1
45E4FF	8	3	±3.75	70	±12.5	2.0	7.0	80	±910	350//5	–	H-1
45E1BF	2	3	±7.5	15	±25	1.0	2.0	65	–910	650//3	–	UM-1
45E2BF	4	3	±7.5	30	±25	1.0	3.0	90	±910	650//3	9	(UM-1) x 2
45E3BF	6	3	±7.5	60	±25	2.0	5.0	80	±910	650//1.5	–	H-1
45E4BF	8	3	±7.5	80	±25	2.0	6.0	80	±910	650//1.5	–	H-1
45E1AF	2	3	±15	10	±50	1.0	2.0	65	–910	1100//–0.9	–	UM-1
45E2AF	4	3	±15	30	±50	1.0	3.0	80	±910	1200//0.7	3.5	(UM-1) x 2

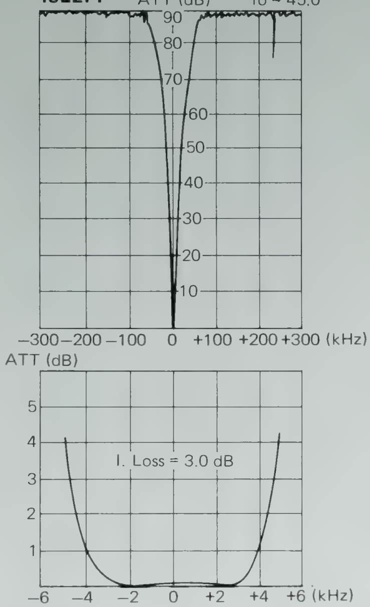
Operating temperature range: –30°C to +80°C

Electrical data

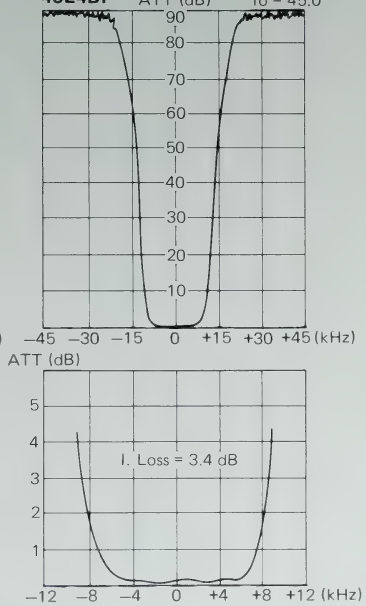
45E1BF



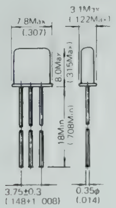
45E2FF



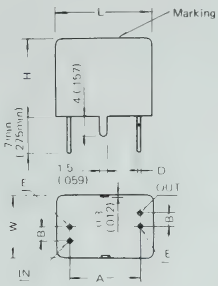
45E4BF



Outline drawing



UM-1
(resistance weld)



H-1

	L	W	H	A	B	Dϕ
H-1	11.0	8.5	11.5	7.4	2.0	0.3

(in mm)

	L	W	H	A	B	Dϕ
H-1	.433	.335	.452	.291	.078	.012

(in inch)

HCM FILTERS

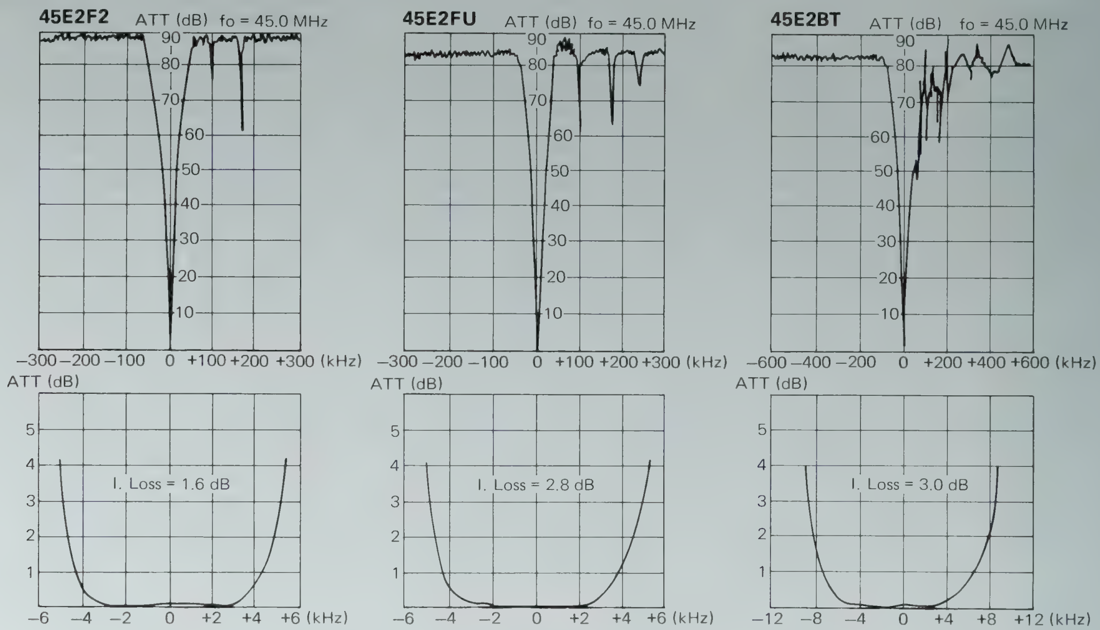
VHF 45MHz 3rd OVERTONE Mode Series
12.5KHz, 25KHz CHANNEL SPACING

Type	No. of pole	Passband (dB)	Passband (kHz)	Stopband (dB)	Stopband (kHz)	Max. ripple (dB)	Max. loss (dB)	Guaranteed attenuation (dB)	Guaranteed attenuation (kHz)	Terminating impedance Zt (Ω//pF)	Coupling impedance Zc (pF)	Case
45E1F	2	3	±3.75	10	±12.5	1.0	2.0	35	±910	2.0K//−0.4	–	UM-1
45E2F2	4	3	±3.75	30	±12.5	1.0	4.0	75	±910	3.0K//−0.3	−0.1	(UM-1) x 2
45E2FU	4	3	±3.75	30	±12.5	1.0	5.0	75	±910	50	–	*S-428
45E2FT	4	3	±3.75	30	±12.5	1.0	5.0	75	±910	50	–	T-2
45E1B	2	3	±7.5	15	±25	1.0	2.0	35	±910	4.0K//−0.7	–	UM-1
45E2B2	4	3	±7.5	30	±25	1.0	3.0	75	±910	4.0K//−0.8	−1.0	(UM-1) x 2
45E2BU	4	3	±7.5	30	±25	1.0	4.0	75	±910	50	–	*S-428
45E2BT	4	3	±7.5	30	±25	1.0	4.0	75	±910	50	–	T-2

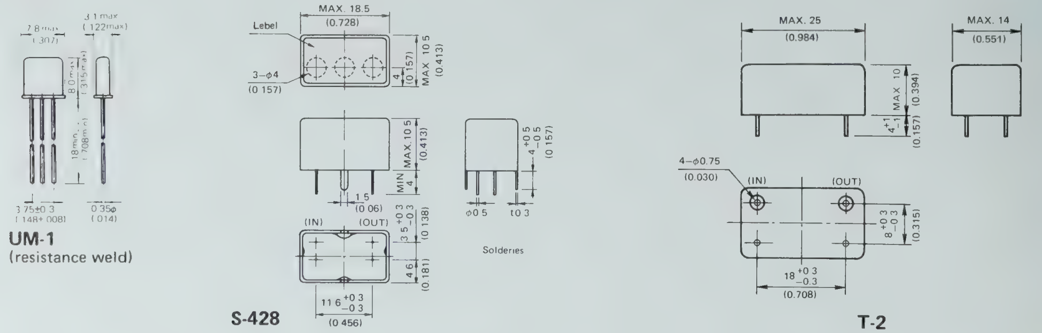
*Non-washable

Operating temperature range: −30°C to +80°C

Electrical data



Outline drawing

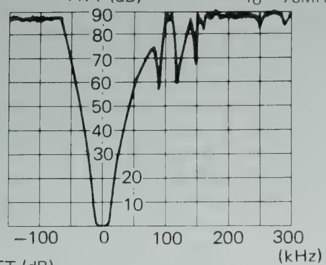


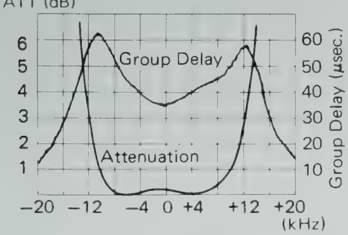
HCM FILTERS Resonator type filters

Type	Center frequency (MHz)	No. of pole	Passband		Stopband		Max. ripple (dB)	Max. loss (dB)	Guaranteed attenuation		Terminating impedance Zt (Ω//pF)	Coupling impedance Zc (pF)	Case
			(dB)	(kHz)	(dB)	(kHz)			(dB)	(kHz)			
70E1B	70	2	3	±7.5	18	±28	1.0	2.0	35 35	+500 to +1000 −200 to −1000	2.0k//−0.9	–	UM-1
70E1D	70	2	3	±10.0	15	±30	1.0	2.0	35 35	+500 to +1000 −200 to −1000	2.5k//−1.0	–	UM-1
70E2B2	70	4	3	±7.5	30	±25	1.0	3.0	70 75	+500 to +1000 −200 to −1000	2.0k//−0.4	−0.5	(UM-1) x 2
70E2D2	70	4	3	±10.0	35	±40	1.0	3.0	70 75	+500 to +1000 −200 to −1000	2.5k//−0.8	−1.0	(UM-1) x 2
90E1B	90	2	3	±7.5	18	±28	1.0	2.0	35 35	+500 to +1000 −200 to −1000	2.0k//−0.1	–	UM-1
90E1D	90	2	3	±10.0	15	±30	1.0	2.0	35 35	+500 to +1000 −200 to −1000	2.5k//−0.4	–	UM-1
90E2B2	90	4	3	±7.5	30	±25	1.0	3.0	70 75	+500 to +1000 −200 to −1000	2.0k//−0.5	−0.3	(UM-1) x 2
90E2D2	90	4	3	±10.0	35	±40	1.0	3.0	70 75	+500 to +1000 −200 to −1000	3.0k//−0.6	−0.8	(UM-1) x 2

Operating temperature: −30°C to +80°C

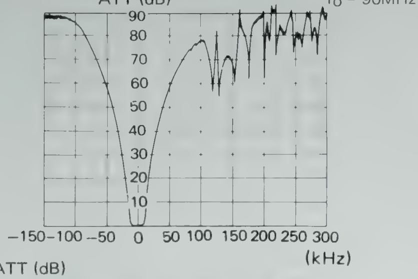
70E2D2

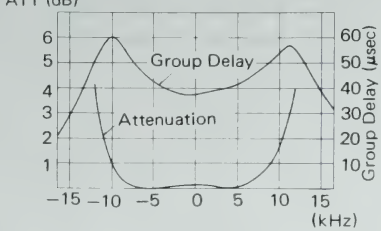




f_0 = 70MHz

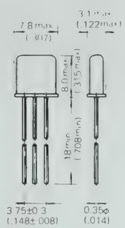
90E2D2





f_0 = 90MHz

Outline drawing



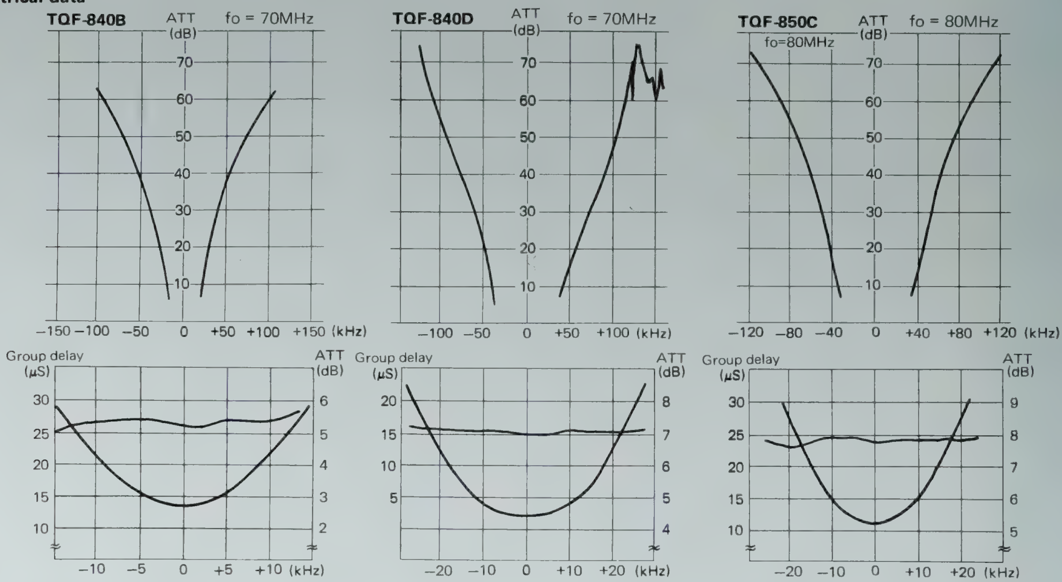
UM-1
(resistance weld)

LINEAR PHASE CRYSTAL FILTERS VHF

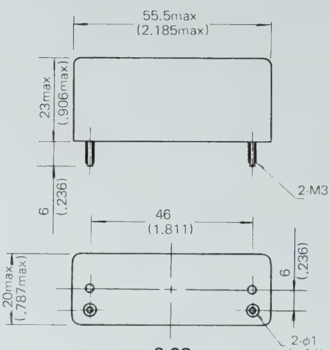
Type	Center frequency (MHz)	No. of pole	Passband		Stopband				Max. loss (dB)	Group delay distortion (μs)	Terminating impedance Zt (Ω//pF)	Case
			(dB)	(kHz)	(dB)	(kHz)	(dB)	(kHz)				
TQF-840A	40 to 90	4	3	±5	40	±35	50	±50	4	5	50	S-411
TQF-840B	50 to 90	4	3	±10	40	±65	50	±90	4	4	50	S-411
TQF-840C	60 to 90	4	3	±15	40	±90	50	±120	6	3	50	S-411
TQF-840D	70 to 90	4	3	±20	40	±120	50	±160	6	2	50	S-411
TQF-850A	50 to 90	6	3	±5	40	±30	60	±45	6	5	50	S-98
TQF-850B	60 to 90	6	3	±10	40	±50	60	±75	6	4	50	S-98
TQF-850C	70 to 90	6	3	±15	40	±70	60	±100	7	3	50	S-98

Operating temperature range: −20 to +70°C

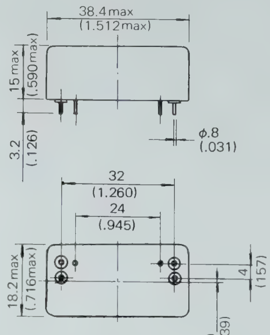
Electrical data



Outline drawing



S-98



S-411

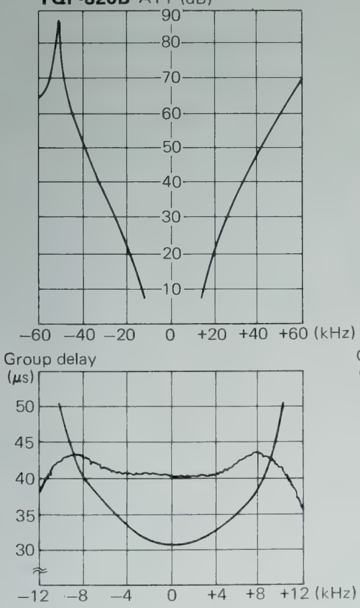
LINEAR PHASE CRYSTAL FILTERS 21.4 MHz

Type	Center frequency (MHz)	No. of pole	Passband (dB)	Passband (kHz)	Stopband (dB)	Stopband (kHz)	Stopband (dB)	Stopband (kHz)	Max. loss (dB)	Group delay distortion (μs)	Terminating impedance Zt (Ω//pF)	Case
TQF-820A	21.4	4	3	±5	–	–	60	±40	4	5	500//10	S-411
TQF-820B	21.4	4	3	±7.5	–	–	60	±55	4	4	500//10	S-411
TQF-820C	21.4	4	3	±12	–	–	60	±100	4	3	500//10	S-411
TQF-821A	21.4	4	3	±15	–	–	60	±120	4	3	500//10	S-411
TQF-821B	21.4	4	3	±30	20	±90	40	±150	5	2	500//10	S-411
TQF-822A	21.4	6	3	±5	40	±20	60	±26	4	8	500//10	S-411
TQF-822B	21.4	6	3	±7.5	40	±28	60	±35	4	5	500//10	S-411
TQF-822C	21.4	6	3	±12	40	±45	60	±55	5	4	500//10	S-411
TQF-823A	21.4	6	3	±15	40	±55	60	±70	5	3	500//10	S-98
TQF-823B	21.4	6	3	±30	40	±120	60	±150	6	2	500//10	S-98
TQF-824B	21.4	8	3	±6	–	–	85	±25	4	20	500//10	S-411

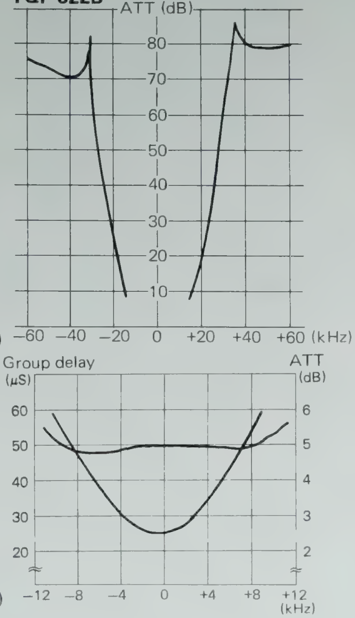
Operating temperature range: –20 to +70°C

Electrical data

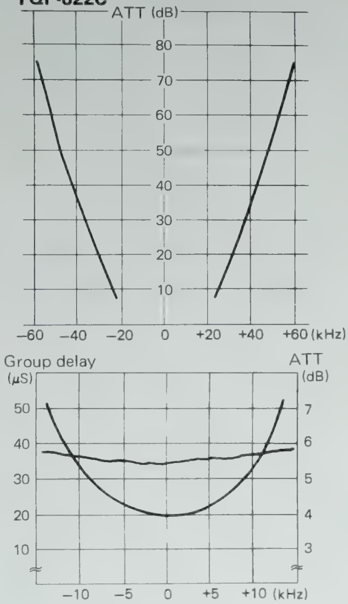
TQF-820B



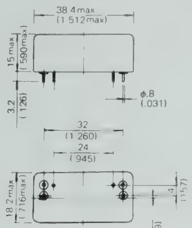
TQF-822B



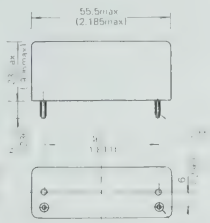
TQF-822C



Outline drawing



S-411



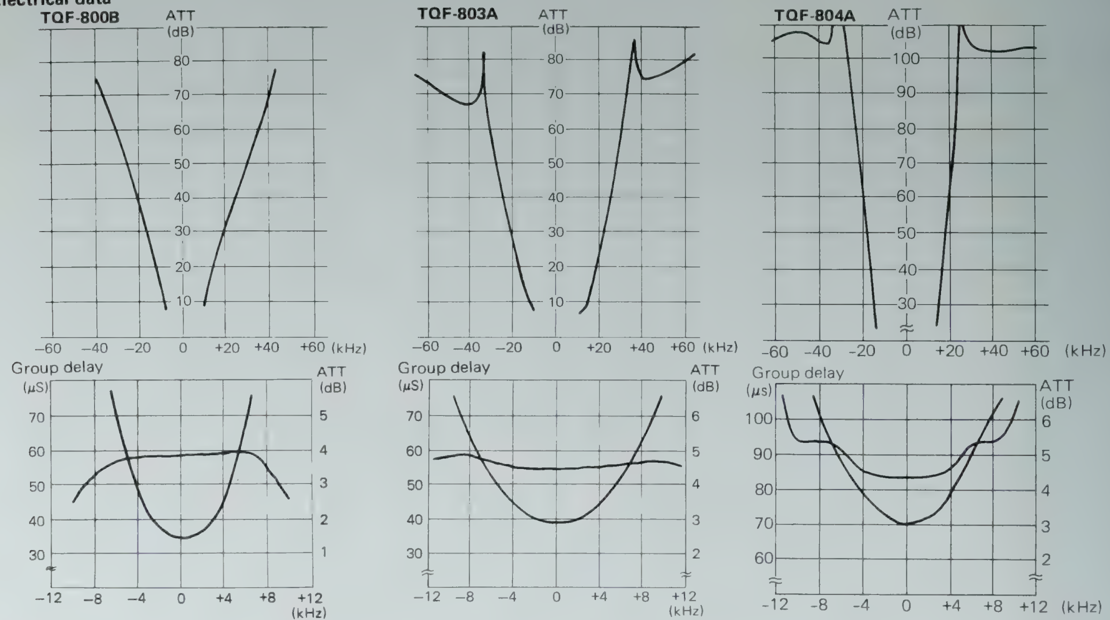
S-98

LINEAR PHASE CRYSTAL FILTERS 10.7 MHz

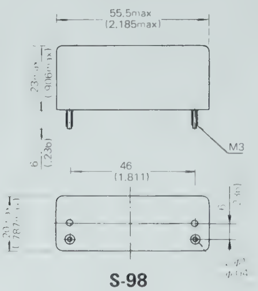
Type	Center frequency (MHz)	No. of pole	Passband		Stopband				Max. loss (dB)	Group delay distortion (μs)	Terminating impedance Zt (Ω//pF)	Case
			(dB)	(kHz)	(dB)	(kHz)	(dB)	(kHz)				
TQF-800A	10.7	4	3	±1.5	–	–	60	±12	3	20	500//10	S-287
TQF-800B	10.7	4	3	±5	–	–	60	±35	3	5	500//10	S-287
TQF-801A	10.7	4	3	±7.5	–	–	60	±50	3	4	500//10	S-287
TQF-801B	10.7	4	3	±15	–	–	60	±120	4	3	500//10	S-287
TQF-801C	10.7	4	3	±30	20	±90	40	±150	5	2	500//10	S-287
TQF-802A	10.7	6	3	±1.5	40	±7.5	60	±10	4	25	500//10	S-287
TQF-802B	10.7	6	3	±5	40	±20	60	±25	4	8	500//10	S-287
TQF-803A	10.7	6	3	±7.5	40	±28	60	±35	4	5	500//10	S-98
TQF-803B	10.7	6	3	±12	40	±45	60	±55	5	4	500//10	S-98
TQF-804A	10.7	8	3	±6	–	–	85	±25	6	20	500//10	S-287

Operating temperature range: –20 to +70°C

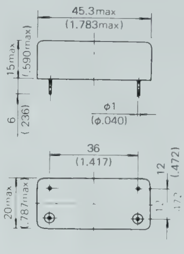
Electrical data



Outline drawing



S-98



S-287

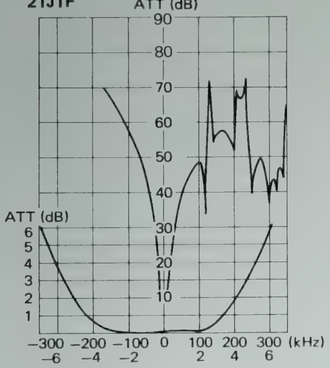
HCM FILTERS

21.4 MHz
12.5 kHz CHANNEL SPACING

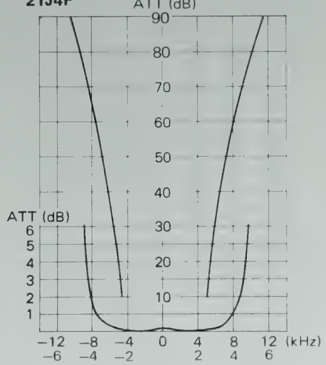
Type	No. of pole	Passband		Stopband				Max. ripple	Max. loss	Guaranteed attenuation		Terminating impedance	Operating temperature	Case
		(dB)	(kHz)	(dB)	(kHz)	(dB)	(kHz)	(dB)	(dB)	(dB)	(fo ± kHz)	Zt (Ω//pF)	(°C)	
21J1F	2	3	±3.75	20	±18	–	–	0.5	1.5	35 50	+350 to +1000 –200 to –1000	850//6	–40 to +80	UM-1
21J2F2	4	3	±3.75	40	±14	–	–	1.0	2.5	65 80	+350 to +1000 –200 to –1000	850//5 Zc : 16 pF	–40 to +80	(UM-1)x2
21J3F	6	3	±3.75	45	±8.75	65	±12.5	2.0	3.0	65	±12.5 to ±300	850//5	–40 to +80	H-1
21J4F	8	3	±3.75	65	±9.0	90	±12.5	2.0	4.0	90	±12.5 to ±300	850//5	–40 to +80	H-1
T14F01-J	8	3	±3.75	70	±9.0	90	±12.5	2.0	4.5	90	±12.5 to ±300	910//15	–40 to +80	T-1
T24F01-J	8	3	±3.75	65	±9.0	90	±12.5	2.0	4.5	90	±12.5 to ±300	470//15	–40 to +80	T-2
21J5F	10	6	±3.75	75	±9.0	90	±10.0	2.0	5.0	90	±10 to ±300	850//5	–40 to +80	H-2

Electrical data

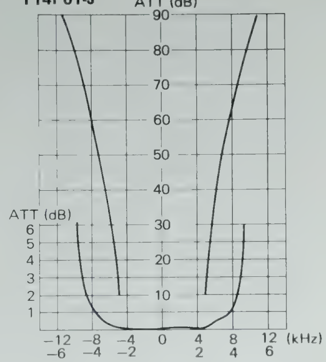
21J1F



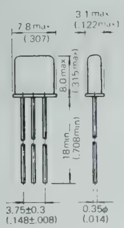
21J4F



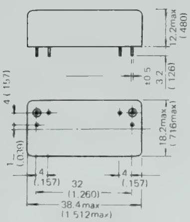
T14F01-J



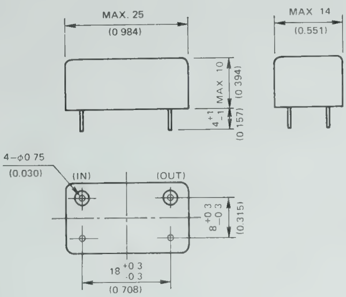
Outline drawing



UM-1
(resistance weld)



T-1



T-2

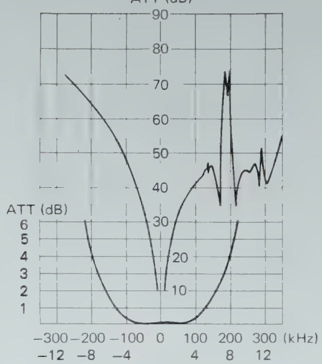
HCM FILTERS

21.4 MHz 20 kHz CHANNEL SPACING

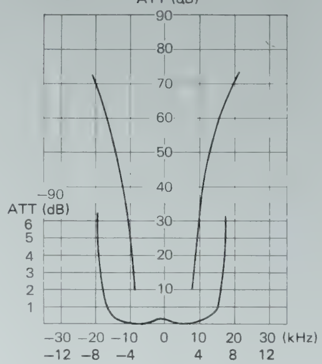
Type	No. of pole	Passband (dB)	Passband (kHz)	Stopband (dB)	Stopband (kHz)	Stopband (dB)	Stopband (kHz)	Max. ripple (dB)	Max. loss (dB)	Guaranteed attenuation (dB)	Guaranteed attenuation (fo ± kHz)	Terminating impedance Zt (Ω//pF)	Operating temperature (°C)	Case
21J1E	2	3	±6.0	20	±25	–	–	0.5	1.5	35 50	+350 to +1000 –200 to –1000	1.2k//3	–40 to +80	UM-1
21J2E2	4	3	±6.0	40	±20	–	–	1.0	2.0	65 80	+350 to +1000 –200 to –1000	1.2k//2.5 Zc : 10.5 pF	–40 to +80	(UM-1)x2
21J3E	6	3	±6.0	45	±14	65	±20	2.0	2.5	65	±20 to ±300	1.2k//2.5	–40 to +80	H-1
21J4E	8	3	±6.0	65	±14	90	±20	2.0	3.0	65	±20 to ±300	1.2k//2.5	–40 to +80	H-1
T14E01-J	8	3	±6.0	70	±14	90	±20	2.0	3.5	90	±20 to ±300	910//15	–40 to +80	T-1
T24E01-J	8	3	±6.0	65	±14	90	±20	2.0	4.0	90	±20 to ±300	470//15	–40 to +80	T-2
21J5E	10	6	±6.0	75	±14	90	±16	2.0	4.0	90	±16 to ±300	1.2k//2.5	–40 to +80	H-2

Electrical data

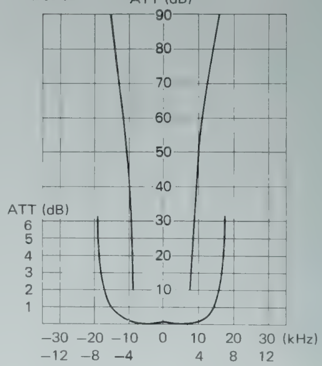
21J1E



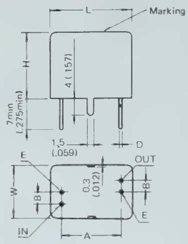
21J3E



21J4E



Outline drawing



(H-3) ~ (H-5)

	L	W	H	A	B	Dφ
H–1	11.0	8.5	11.5	7.4	2.0	0.3
H–2	13.4	8.5	11.0	9.8	2.0	0.3
H–3	15	12	15	9.0	2.5	0.43
H–4	18.5	12	15	13.4	2.5	0.43
H–5	23	12	15	17.8	2.5	0.43
H–6	28	12	15	22.2	2.5	0.43

(in mm)

	L	W	H	A	B	Dφ
H–1	.433	.335	.452	.291	.078	.012
H–2	.527	.335	.433	.386	.078	.012
H–3	.590	.472	.590	.354	.098	.017
H–4	.728	.472	.590	.527	.098	.017
H–5	.906	.472	.590	.701	.098	.017
H–6	1.102	.472	.590	.874	.098	.017

(in inch)

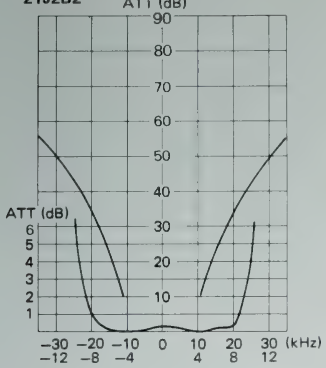
HCM FILTERS

21.4 MHz
25 kHz CHANNEL SPACING

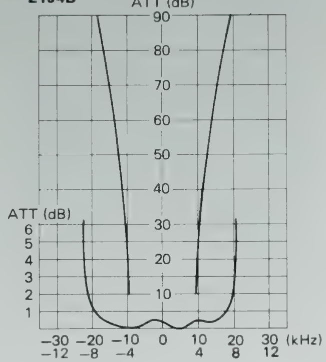
Type	No. of pole	Passband		Stopband				Max. ripple	Max. loss	Guaranteed attenuation		Terminating impedance	Operating temperature	Case
		(dB)	(kHz)	(dB)	(kHz)	(dB)	(kHz)	(dB)	(dB)	(dB)	(fo ± kHz)	Zt (Ω//pF)	(°C)	
21J1B	2	3	±7.5	18	±25	–	–	0.5	1.5	35 50	+350 to +1000 –200 to –1000	1.5k//2.5	–40 to +80	UM-1
21J2B2	4	3	±7.5	40	±25	–	–	1.0	2.0	65 80	+350 to +1000 –200 to –1000	1.5k//2.0 Zc : 8 pF	–40 to +80	(UM-1)x2
21J3B	6	3	±7.5	45	±17.5	65	±25	2.0	2.5	65	±25 to ±300	1.5k//2.0	–40 to +80	H-1
21J4B	8	3	±7.5	65	±17.5	90	±25	2.0	3.0	90	±25 to ±300	1.5k//2.0	–40 to +80	H-1
T14B01-J	8	3	±7.5	70	±17.5	90	±25	2.0	3.5	90	±25 to ±300	910//15	–40 to +80	T-1
T24B01-J	8	3	±7.5	65	±17.5	90	±25	2.0	4.0	90	±25 to ±300	470//15	–40 to +80	T-2
21J5B	10	6	±7.5	75	±16	90	±18	2.0	4.0	90	±18 to ±300	1.5k//2.0	–40 to +80	H-2

Electrical data

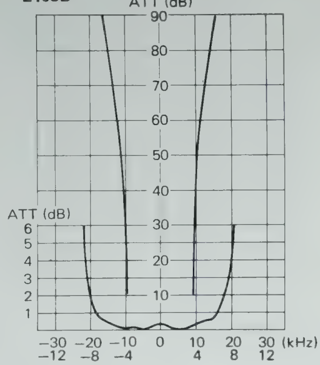
21J2B2



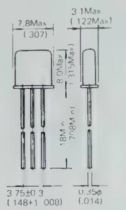
21J4B



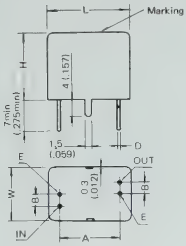
21J5B



Outline drawing



UM-1
(resistance weld)



(H-1) ~ (H-5)

	L	W	H	A	B	Dφ
H–1	11.0	8.5	11.5	7.4	2.0	0.3
H–2	13.4	8.5	11.0	9.8	2.0	0.3
H–3	15	12	15	9.0	2.5	0.43
H–4	18.5	12	15	13.4	2.5	0.43
H–5	23	12	15	17.8	2.5	0.43
H–6	28	12	15	22.2	2.5	0.43

(in mm)

	L	W	H	A	B	Dφ
H–1	.433	.335	.452	.291	.078	.012
H–2	.527	.335	.433	.386	.078	.012
H–3	.590	.472	.590	.354	.098	.017
H–4	.728	.472	.590	.527	.098	.017
H–5	.906	.472	.590	.701	.098	.017
H–6	1.102	.472	.590	.874	.098	.017

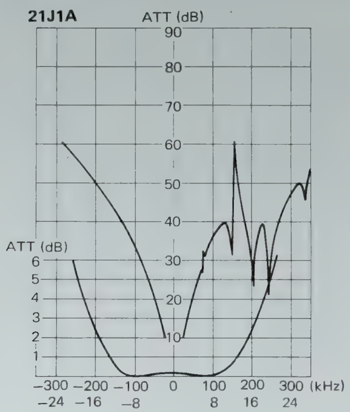
(in inch)

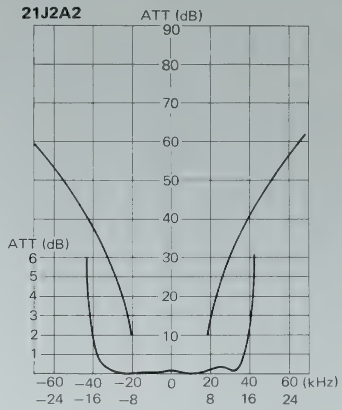
HCM FILTERS

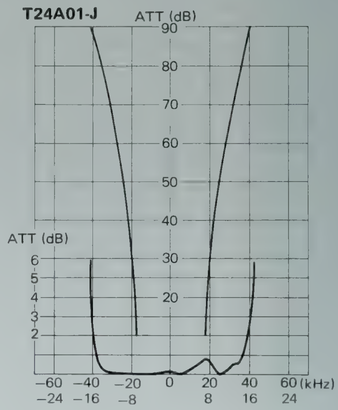
21.4 MHz
50 kHz CHANNEL SPACING

Type	No. of pole	Passband		Stopband				Max. ripple	Max. loss	Guaranteed attenuation		Terminating impedance	Operating temperature	Case
		(dB)	(kHz)	(dB)	(kHz)	(dB)	(kHz)	(dB)	(dB)	(dB)	(fo ± kHz)	Zt (Ω//pF)	(°C)	
21J1A	2	3	±15	15	±45	–	–	0.5	1.5	35 45	+350 to +1000 –300 to –1000	1.5k//1.0	–40 to +80	UM-1
21J2A2	4	3	±15	40	±50	–	–	1.0	2.0	65 80	+350 to +1000 –250 to –1000	2.0k//0.5 Zc : 3 pF	–40 to +80	(UM-1)x2
21J3A	6	3	±15	45	±35	65	±50	2.0	2.5	65	±50 to ±300	2.2k//0.5	–40 to +80	H-1
21J4A	8	3	±15	65	±35	80	±50	2.0	3.0	80	±50 to ±300	2.2k//0.5	–40 to +80	H-1
T14A01-J	8	3	±15	70	±35	90	±50	2.0	3.5	90	±50 to ±300	910//15	–40 to +80	T-1
T24A01-J	8	3	±15	65	±35	80	±50	2.0	4.0	80	±50 to ±300	470//15	–40 to +80	T-2

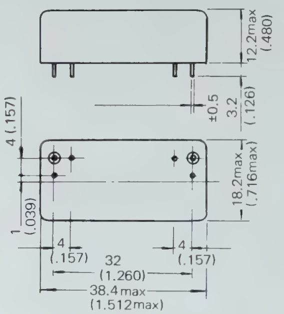
Electrical data



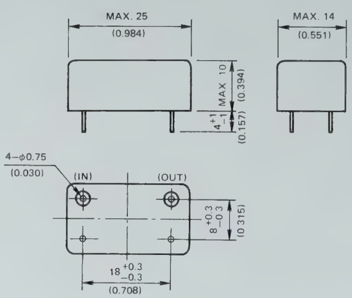




Outline drawing



T-1



T-2

HCM FILTERS

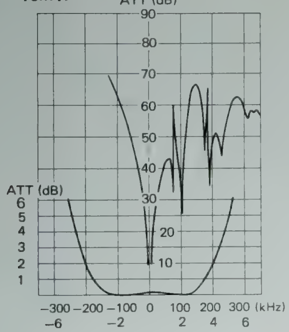
10.7 MHz 12.5 kHz CHANNEL SPACING

Type	No. of pole	Passband		Stopband				Max. ripple	Max. loss	Guaranteed attenuation		Termination		Operating temperature	Case
												impedance	Recommendable transformer		
		(dB)	(kHz)	(dB)	(kHz)	(dB)	(kHz)	(dB)	(dB)	(dB)	(fo ± kHz)	Zt (Ω//pF)	(see remark)	(°C)	
10M1F	2	3	±3.75	20	±18	–	–	0.5	1.5	35 50	+300 to +1000 –200 to –1000	1.8k//5.0	*1	–40 to +80	HC-49/U
10M2F2	4	3	±3.75	40	±14	–	–	1.0	2.5	65 80	+300 to +1000 –200 to –1000	1.8k//4.5 Zc : 12 pF	*1	–40 to +80	(HC-49/U)x2
H33F01	6	3	±3.75	45	±8.75	65	±12.5	2.0	3.5	65	±12.5 to ±300	1.8k//3.5	*1	–40 to +80	H-3
H44F01	8	3	±3.75	65	±8.75	90	±12.5	2.0	4.0	90	±12.5 to ±300	1.8k//3.5	*1	–40 to +80	H-4
T14F01-M	8	3	±3.75	70	±8.75	90	±12.5	2.0	4.5	90	±12.5 to ±300	910//25	–	–40 to +80	T-1

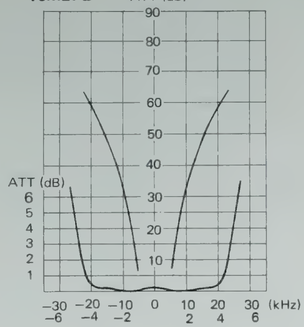
*See "matching transformer" on page 48.

Electrical data

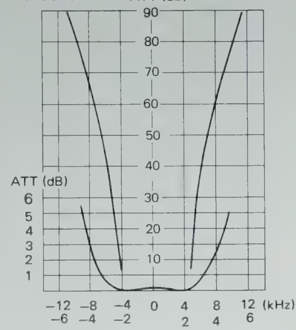
10M1F



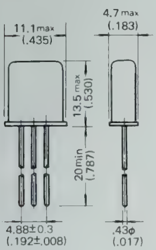
10M2F2



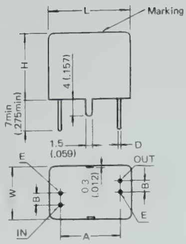
H44F01



Outline drawing



HC-49/U
(resistance weld)



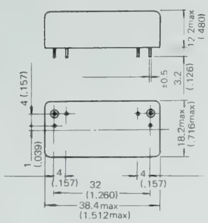
(H-3) and (H-4)

	L	W	H	A	B	Dφ
H–1	11.0	8.5	11.5	7.4	2.0	0.3
H–2	13.4	8.5	11.0	9.8	2.0	0.3
H–3	15	12	15	9.0	2.5	0.43
H–4	18.5	12	15	13.4	2.5	0.43
H–5	23	12	15	17.8	2.5	0.43
H–6	28	12	15	22.2	2.5	0.43

(in mm)

	L	W	H	A	B	Dφ
H–1	.433	.335	.452	.291	.078	.012
H–2	.527	.335	.433	.386	.078	.012
H–3	.590	.472	.590	.354	.098	.017
H–4	.728	.472	.590	.527	.098	.017
H–5	.960	.472	.590	.701	.098	.017
H–6	1.102	.472	.590	.874	.098	.017

(in inch)



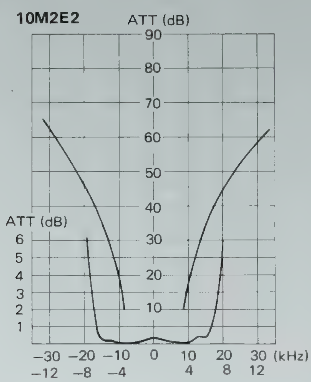
T-1

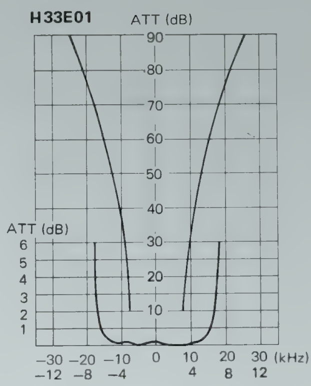
HCM FILTERS

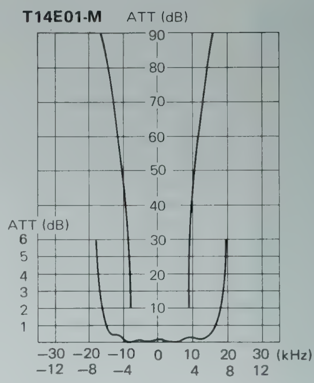
10.7 MHz
20 kHz CHANNEL SPACING

Type	No. of pole	Passband		Stopband				Max. ripple	Max. loss	Guaranteed attenuation		Termination		Operating temperature	Case
												impedance Zt (Ω//pF)	Recom-mendable transformer (see below)		
		(dB)	(kHz)	(dB)	(kHz)	(dB)	(kHz)	(dB)	(dB)	(dB)	(fo ± kHz)			(°C)	
10M1E	2	3	±6.0	20	±25	–	–	0.5	1.5	35 40	+300 to +1000 –200 to –1000	2.5k//2.5	*3	–40 to +80	HC-49/U
10M2E2	4	3	±6.0	40	±20	–	–	1.0	2.5	65 80	+300 to +1000 –200 to –1000	1.8k//2.5 Zc : 7 pF	*3	–40 to +80	(HC-49/U)x2
H33E01	6	3	±6.0	45	±14	65	±20	2.0	2.5	65	±20 to ±300	2.8k//1.0	*3	–40 to +80	H-3
H44E01	8	3	±6.0	65	±14	90	±20	2.0	4.0	90	±20 to ±300	2.8k//1.0	*3	–40 to +80	H-4
T14E01-M	8	3	±6.0	70	±14	90	±20	2.0	3.5	90	±20 to ±300	910//25	–	–40 to +80	T-1

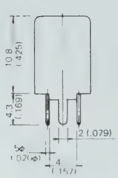
Electrical data

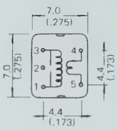






Matching transformer





No.	Type	Impedance ratio
*1	009D	1.8 kΩ : 910 Ω
*2	009C	3.4 kΩ : 910 Ω
*3	009B	2.8 kΩ : 910 Ω
*4	10B02	3 kΩ : 200 Ω
*5	10B10	3 kΩ : 1 kΩ
*6	10A02	5 kΩ : 200 Ω
*7	10A10	5 kΩ : 1 kΩ

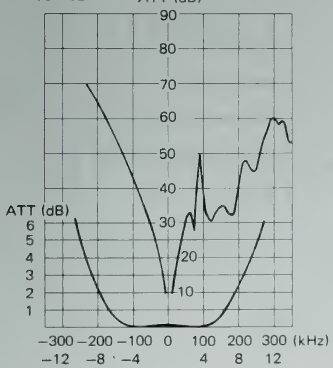
HCM FILTERS

10.7 MHz
25 kHz CHANNEL SPACING

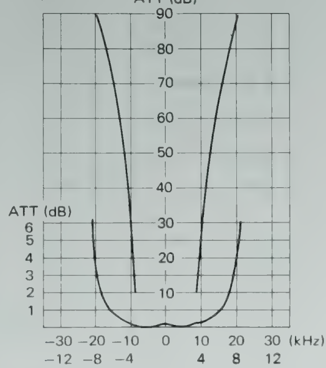
Type	No. of pole	Passband		Stopband				Max. ripple	Max. loss	Guaranteed attenuation		Termination		Operating temperature	Case
		(dB)	(kHz)	(dB)	(kHz)	(dB)	(kHz)	(dB)	(dB)	(dB)	(fo ± kHz)	impedance Zt (Ω//pF)	Recom-mendable transformer (see remark)	(°C)	
10M1B	2	3	±7.5	18	±25	–	–	0.5	1.5	35 40	+300 to +1000 –200 to –1000	3.0k//2.0	*4, *5	–40 to +80	HC-49/U
10M2B	4	3	±7.5	40	±25	–	–	1.0	2.5	40	±25 to ±300	3.0k//1.5	*4, *5	–40 to +80	H-3
10M2B2	4	3	±7.5	40	±25	–	–	1.0	2.5	65 80	+300 to +1000 –200 to –1000	3.0k//1.5 Zc : 5 pF	*4, *5	–40 to +80	(HC-49/U)x2
10M3B	6	6	±7.5	60	±22.5	–	–	2.0	3.0	60	±22.5 to ±300	2.8k//1.0	*3, *4 *5	–40 to +80	H-3
H33B01	6	3	±7.5	45	±17.5	65	±25	2.0	2.5	65	±25 to ±300	3.4k//0.5	*2	–40 to +80	H-3
10M4B	8	6	±7.5	60	±15	80	±20	2.0	3.5	80	±20 to ±300	2.8k//1.0	*3, *4, *5	–40 to +80	H-4
T14B01-M	8	3	±7.5	70	±17.5	90	±25	2.0	3.5	90	±25 to ±300	910//25	–	–40 to +80	T-1
10M5B	10	6	±7.5	75	±15	90	±17.5	2.0	4.0	90	±17.5 to ±300	2.8k//1.0	*3, *4, *5	–40 to +80	H-5

Electrical data

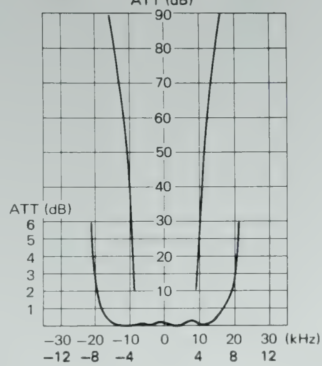
10M1B



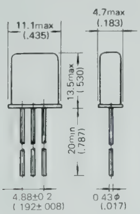
10M4B



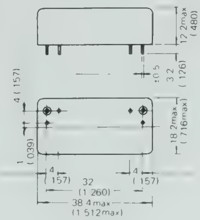
10M5B



Outline drawing



HC-49/U
(resistance weld)



T-1

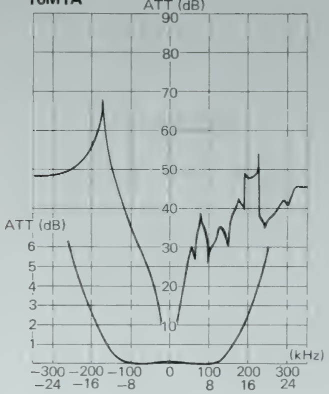
HCM FILTERS

10.7 MHz
50 kHz CHANNEL SPACING

Type	No. of pole	Passband		Stopband				Max. ripple	Max. loss	Guaranteed attenuation		Termination impedance	Termination: Recommendable transformer	Operating temperature	Case
		(dB)	(kHz)	(dB)	(kHz)	(dB)	(kHz)	(dB)	(dB)	(dB)	(fo ± kHz)	Zt (Ω//pF)	(see below)	(°C)	
10M1A	2	3	±15	15	±50	–	–	0.5	1.5	30 40	+300 to +1000 –300 to –1000	5.0k//0	*6, *7	–40 to +80	HC-49/U
10M2A	4	3	±15	30	±40	–	–	1.0	2.5	30	±40 to ±300	5.5k//–1.0	*6, *7	–40 to +80	H-3
10M2A2	4	3	±15	30	±40	–	–	1.0	2.5	65 80	+300 to +1000 –250 to –1000	5.5k//–1.0 Zc : 0 pF	*6, *7	–40 to +80	(HC-49/U)x2
10M4A	8	6	±15	60	±30	80	±40	2.0	3.5	80	±40 to ±300	5.5k//–1.0	*6, *7	–40 to +80	H-4
T14A01-M	8	3	±15	70	±35	90	±50	2.0	3.5	90	±50 to ±300	910//25	–	–40 to +80	T-1

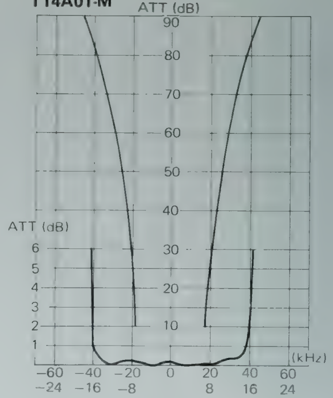
Electrical data

10M1A

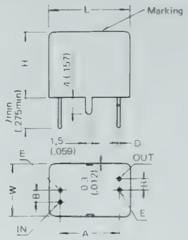


10M2A2

T14A01-M



Outline drawing



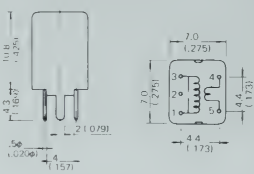
	L	W	H	A	B	Dφ
H–1	11.0	8.5	11.5	7.4	2.0	0.3
H–2	13.4	8.5	11.0	9.8	2.0	0.3
H–3	15	12	15	9.0	2.5	0.43
H–4	18.5	12	15	13.4	2.5	0.43
H–5	23	12	15	17.8	2.5	0.43
H–6	28	12	15	22.2	2.5	0.43

(in mm)

	L	W	H	A	B	Dφ
H–1	.433	.335	.452	.291	.078	.012
H–2	.527	.335	.433	.386	.078	.012
H–3	.590	.472	.590	.354	.098	.017
H–4	.728	.472	.590	.527	.098	.017
H–5	.906	.472	.590	.701	.098	.017
H–6	1.102	.472	.590	.874	.098	.017

(H-3) ~ (H-5) (in inch)

Matching transformer



No.	Type	Impedance ratio
*1	009D	1.8 kΩ : 910 Ω
*2	009C	3.4 kΩ : 910 Ω
*3	009B	2.8 kΩ : 910 Ω
*4	10B02	3 kΩ : 200 Ω
*5	10B10	3 kΩ : 1 kΩ
*6	10A02	5 kΩ : 200 Ω
*7	10A10	5 kΩ : 1 kΩ

Crystal Filters

TOYOCOM

HCM FILTERS

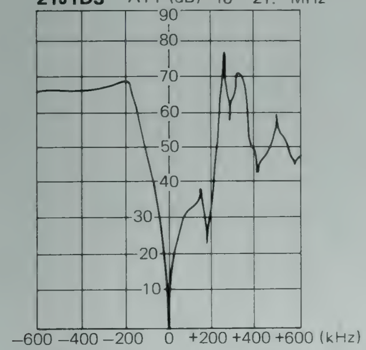
Miniature Package UM-5 for PAGER SYSTEM

Type	Center frequency (MHz)	No. of pole	Passband		Stopband		Max. ripple (dB)	Max. loss (dB)	Guaranteed attenuation		Terminating impedance Zt (Ω//pF)	Case
			(dB)	(kHz)	(dB)	(kHz)			(dB)	(kHz)		
21J1D3	21.4	2	3	±10	13	±30	1.0	1.5	35 60	+350 to +1000 –300 to –1000	1.8k//1.0	UM-5
21J1B3	21.4	2	3	±7.5	15	±25	1.0	1.5			1.5k//2.5	UM-5
21M1B3	21.7	2	3	±7.5	15	±25	1.0	1.5			1.5k//2.5	UM-5
TQF-602A	26 to 50	2	3	±10	10	±30	1.0	2.0	35 60	+910 –910	1.5k//2.5 ± 2	UM-5

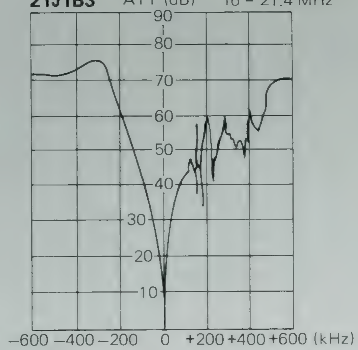
Operating temperature range: –30°C to +80°C

Electrical data

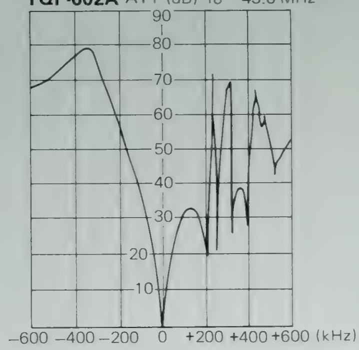
21J1D3 ATT (dB) fo = 21. MHz

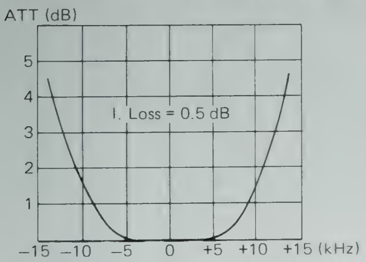


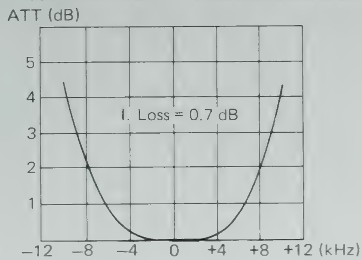
21J1B3 ATT (dB) fo = 21.4 MHz

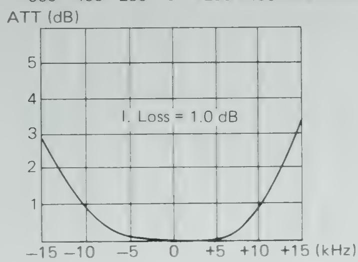


TQF-602A ATT (dB) fo = 43.0 MHz

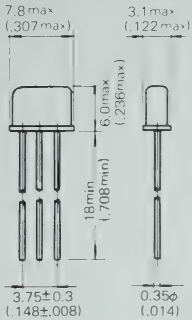








Outline drawing

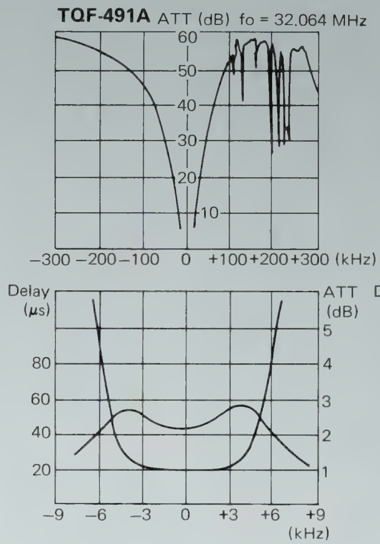


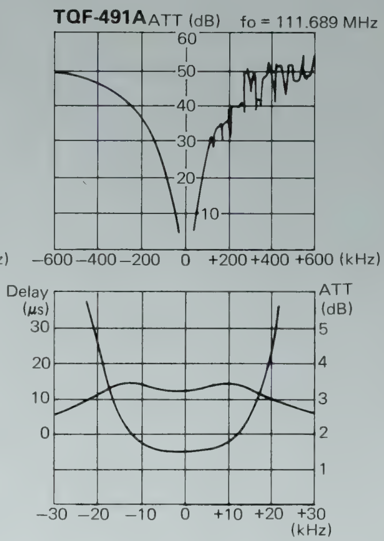
UM-5 (resistance weld)

PCM PILOT FILTERS

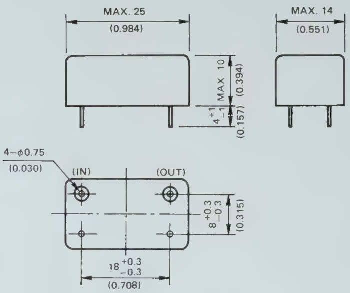
Type	TQF-491A		
Center Frequency (fo)	30 to 150 MHz		
No. of Pole	2		
Passband	3 dB: fo ± (fo x 1.5 x 10^{-4}) min.		
Stopband	20 dB: fo ± (fo x 1.5 x 10^{-3}) max. 40 dB: fo ± (fo x 7.5 x 10^{-3}) max.		
Spurious Response	10 dB min.		
Ripple	1 dB max.		
Insertion Loss	4 dB max.		
Terminating Impedance	50Ω		
Phase Variation	(vs. Freq.) (vs. Temp.)	±12 deg. max. ±20 deg. max.	fo ± (fo x 15 x 10^{-4}) −10 to +60°C
Temperature Range	−10 to +60°C		
Operating Input Voltage	0.2V max.		
Case	T-2		

Electrical data

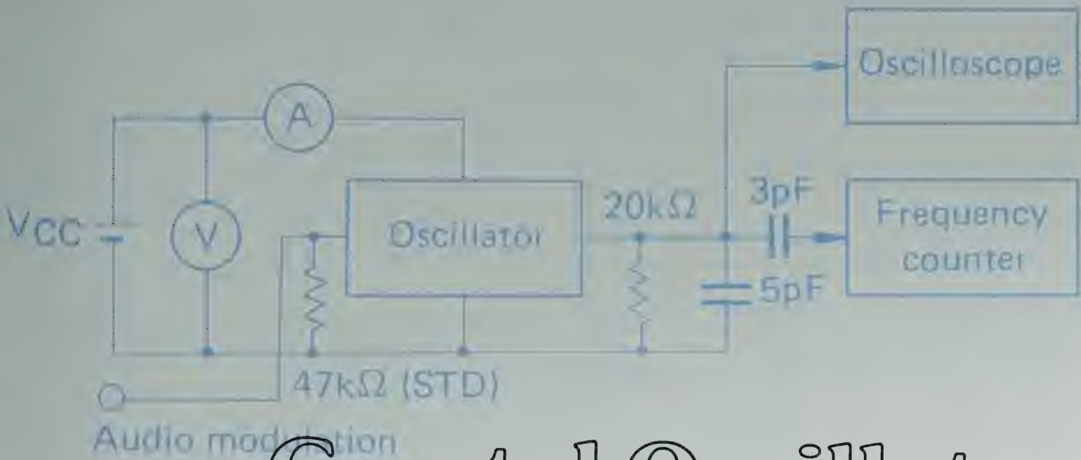




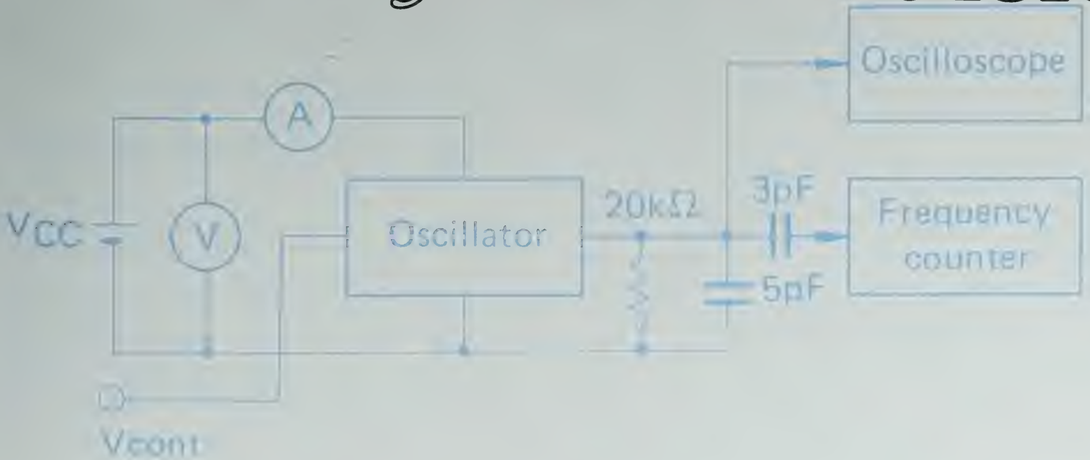
Outline drawing



T-2



Crystal Oscillators



INTRODUCTION

TOYOCOM crystal oscillators are manufactured by using TOYOCOM crystal resonator on sophisticated techniques and optimum circuit design which produces high stable frequency and high quality.
Since TOYOCOM crystal oscillators are stringently inspected by a computer controlled inspection system and produced by an amply studied quality control system, they have high reliability.
TOYOCOM crystal oscillators are, therefore, widely used as a precision frequency reference source in communication and electronic equipment around the world. Especially, TOYOCOM has a big market share in the industrial field such as the 900 MHz cellular mobile telephone system in the world.
The abundant TOYOCOM crystal oscillators are classified according to function as shown in the table (on page 56, 57).
Since this table also shows the frequency range that can be manufactured as well as typical application examples, it will help the user with type selection.

1. SPXO (Simple Packaged Crystal Oscillator)

An SPXO has frequency-temperature characteristics obtained by crystal resonator and has no temperature compensation circuit.
TOYOCOM has designed it under the optimum circuit conditions by the circuit simulation analysis so that the best characteristics of the crystal oscillators are obtained.

2. VCXO (Voltage Controlled Crystal Oscillator)

A VCXO is a crystal oscillator of which frequency is controlled by a external control voltage applied to the crystal oscillator. Usually, a variable capacitance component such as a varactor diode is used in the oscillation circuit as the frequency control element are shown in Fig.1.

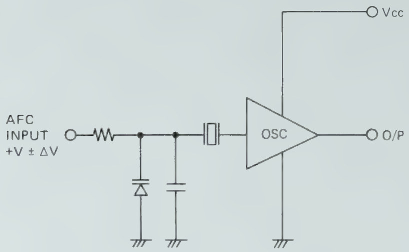


Fig. 1 Basic AFC input construction of a VCXO

Fig.2 and Fig.3 show the V-F characterisitics depending on the AFC (Automatic Frequency Control) input configuration in the VCXO.
In the case of Fig.2 the V-F characteristic shows a positive slope, on the other hand, a negative slope is shown in Fig.3. Either way is applicable to the TOYOCOM's VCXO, basing on customer's specifications.

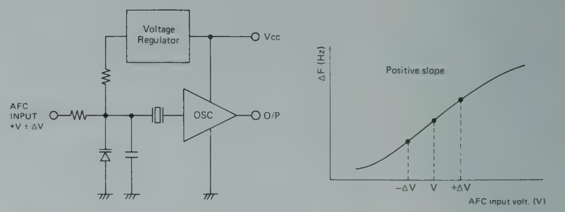


Fig. 2 VCXO AFC input configuration for the positive slope characteristics

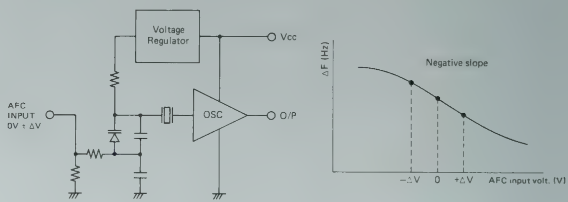


Fig. 3 VCXO AFC input configuration for the negative slope characteristics

Our VCXOs are widely used in communication and electronic equipment as frequency modulators and a part of a phase-locked loop as shown in Fig.4.
TCO-205 is a VCXO having an excellent SSB phase-noise characteristics (for instance, -110dB/Hz at 100Hz offset from carrier frequency) and is applicable to a measurement equipment such as spectrum analyzers and also used in a satellite communication system like VSAT as high purity signal source.

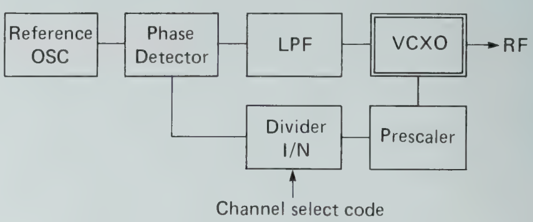


Fig. 4 An application of a VCXO for frequency synthesizer

3. TCXO (Temperature Compensated Crystal Oscillator)
A TCXO is a crystal oscillator with a temperature-sensitive reactance circuit in its oscillation loop to compensate the frequency-temperature characteristics inherent to the crystal resonator.
TOYOCOM TCXOs are classified into a direct compensation type called TCO-900 series and an indirect compensation type called TCO-500 series by the used temperature compensation method.
In the case of TCO-900 series, the temperature compensation circuit is inserted directly into the crystal oscillation loop as shown in Fig.5, so called direct-type TCXO. Since the supply of stable power to the temperature compensation circuit is unnecessary, power consumption and case size of TCO-900 series can be extremely reduced.

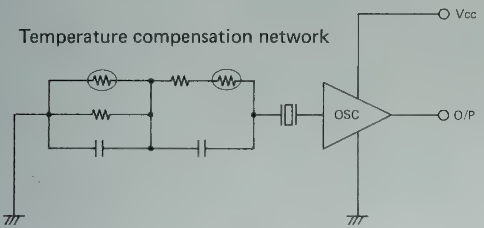


Fig. 5 Simplified schematic of the direct type TCXO

Because of these features, TCO-900 series is widely used as a reference oscillator of synthesizers that generate channel frequencies in the worldwide 800 MHz/900 MHz cellular mobile telephone and portable telephone market.
In case of TCXO called TCO-500 series, on the other hand, the temperature compensation is performed by the indirect compensation method which means the temperature compensation circuit located outside of the oscillation loop and controls a variable reactance component such as a varactor diode as shown in Fig.6.

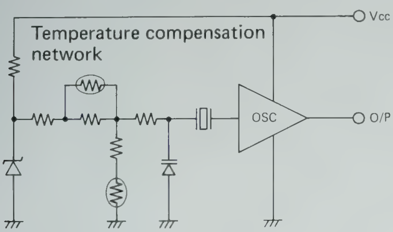


Fig. 6 Simplified schematic of the indirect type TCXO

High frequency stability is easily obtained over a wide temperature range with this compensation method, this TCXO is used as a reference source for mobile telephone base stations.
Since the values of the temperature compensation circuit are calculated and selected by CAD (Computer Aided Design) in the production process, excellent frequency stability is guaranteed.

4. DTCXO (Digitally Temperature Compensated Crystal Oscillator)
DTCXO is a TCXO compensated by using digital technology to obtain ultra-high frequency stability. TOYOCOM's DTCXO is constructed as Fig.7 and has the following characteristic features:

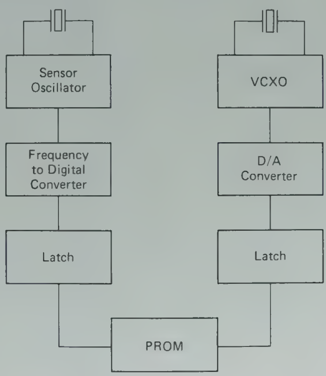


Fig. 7 Simplified Block Diagram of the DTCXO

1. High frequency stability (±0.2ppm max./–10 to +60° C)
2. Low power consumption (15mA max./ +10V operation)
3. Compactness (small size of only 40×40×15h in mm)
4. Non-warm-up (high stability is guaranteed at the start of operation)

Since this DTCXO is compensated individually over the full temperature range and the digital compensation code is prewritten in the PROM, high frequency stability can be obtained at the moment of system power-on.
From above benefits, TOYOCOM's DTCXO is used as the reference oscillator in the base stations for a 900 MHz cellular mobile telephone system and paging system.

5. OCXO (Oven Controlled Crystal Oscillator)
With an OCXO, high frequency stability is obtained by putting the crystal resonator or the crystal oscillator itself in a high precision oven which keeps the ambient temperature constantly. Since the set temperature of the oven is adjusted to the zero temperature coefficient of each crystal oscillator, high stability is obtained.
Because an AGC (Automatic Gain Control) curcuit is provided in the oscillation circuit of TCO-613, TCO-615 and TCO-632 series, short-term frequency stability and frequency versus supply voltage characteristics are excellent.
Therefore, these are widely used in satellite navigation system such as NNSS.
The newly developed TCO-635 series are very small and fast warm-up type OCXO (within $\pm 5\times10^{-8}$ typ. / 5 minutes at 25° C) and are used as the frequency source of satellite communication system like VSAT.

Crystal Oscillators

TOYOCOM

TOYOCOM OSCILLATORS LINE-UP

TYPE	MODEL	FREQUENCY AVAILABILITY (MHz)	APPLICATIONS	PAGE
SPXO	TCO-312A	20 – 200	• Computer • PCM system	58
VCXO	TCO-730C	12 – 20	• Video camera • Measurement equipment • PCM timing recovery • Microwave system	59
	TCO-205M	60 – 150		60
TCXO	TCO-512X	4 – 25	• Marine radio system • Frequency synthesizer • Cellular mobile radio	62
	TCO-519A·L	10 – 24		64
TCXO	TCO-909Z	10 – 20	• Cellular mobile radio • Portable radio	66
	TCO-919A·R	12 – 20		61
OCXO	TCO-635A	5 – 25	• Mobile telephone base station • Satellite communication system • Satellite navigation system • Frequency counter and synthesizer • EPIRB system	70
	TCO-612	1 – 10		68
	TCO-627	4 – 10		70
	TCO-632B	10.0 only		70
	TCO-613A	5 – 7		68
	TCO-615	5 – 10		68
DTCXO	TCO-101	10 – 20	• Mobile telephone base station • Satellite communication system	72

Crystal Oscillators

TOYOCOM

FREQUENCY STABILITY vs. PACKAGE SIZE

STABILITY vs. Temp.	Model	Size	Volume (cc)
$\pm 30\times10^{-6}$/–20 to 70°C	TCO-730C	20.32x12.7x8.5	
$\pm 10\times10^{-6}$/0 to 50°C	TCO-205M	25x25x15	
$\pm 10\times10^{-6}$/0 to 60°C	TCO-312A	33x21x9	
$\pm 2.5\times10^{-6}$/–30 to 75°C	TCO-909Z	18.3x11.7x9	
$\pm 2.5\times10^{-6}$/–30 to 75°C	TCO-919A·R	18.3x11.7x10	
$\pm 2\times10^{-6}$/–30 to 85°C	TCO-519A	20x20x10	
$\pm 1\times10^{-6}$/–10 to 60°C	TCO-512X	35.8x26.3x10	
$\pm 1\times10^{-6}$/–20 to 70°C	TCO-519L	20x20x10	
$\pm 2\times10^{-7}$/–10 to 60°C	TCO-101	40x40x15	
$\pm 1\times10^{-7}$/–20 to 70°C	TCO-635	30x30x22	
$\pm 5\times10^{-8}$/–10 to 60°C	TCO-627	40x40x25	
$\pm 5\times10^{-8}$/–10 to 60°C	TCO-612	40x40x56	
$\pm 3\times10^{-8}$/–10 to 60°C	TCO-632	40x40x35	
$\pm 1\times10^{-8}$/–10 to 60°C	TCO-613A -615A	50x50x60	
$\pm 5\times10^{-9}$/–10 to 60°C	TCO-615B	50x50x60	

Volume (cc): 1, 2, 3, 5, 7, 10, 20, 30, 50, 70, 100, 200

SPXO TCO-312 Series

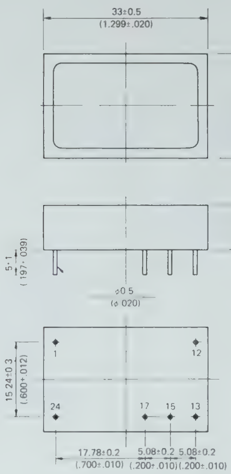
Applications
- Computer
- PCM system

Features
- Compact size
- ECL interface available

Model	TCO-312A
Standard frequency	100 MHz
Frequency available range	20 to 200 MHz
Frequency stability vs. Temperature vs. Supply voltage Aging	 ±10 ppm/0 to +60°C ±1 ppm/+5V ± 5% ±3 ppm/year
Supply voltage	+5V ± 5%
Supply current	20 mA max.
Output	0.4 to 1.0 Vp-p/110Ω
Operable temperature range	−20 to +75°C

Outline drawing

TCO-312A

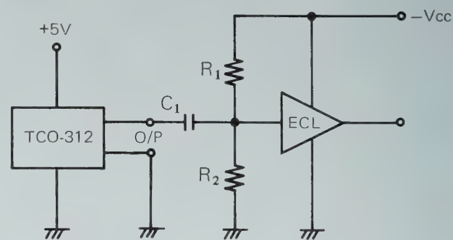


Pin connections

1	NC
12, 17	Common and case
13, 15	Output
24	$+V_{CC}$

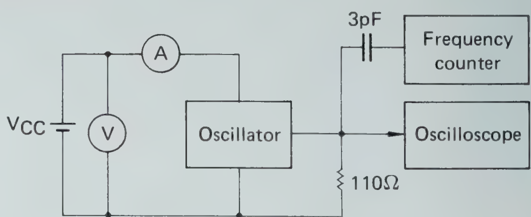
Size in mm
(inch)

ECL interface



C_1, R_1 and R_2 should be determined by customer.

Test circuit



VCXO TCO-730 Series

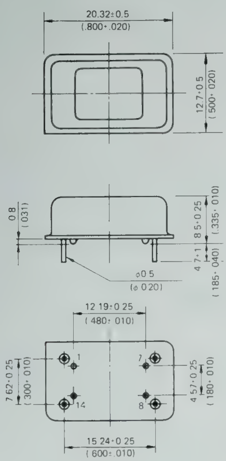
Applications
- Video camera
- PCM system

Features
- Compact size
- 14-pin DIP IC compatible
- TTL compatible output
- Hermetically sealed metal package (washable)

Model	TCO-730C
Standard frequency	14.31818 MHz or 16.384 MHz
Frequency available range	12 to 20 MHz
Frequency stability	
vs. Temperature	±30 ppm/−20 to +70°C
vs. Supply voltage	±1 ppm/+5V ± 5%
Aging	±3 ppm/year
Supply voltage	+5V ± 5%
Supply current	16 mA max.
Output	TTL compatible, Fan-out 2
Operable temperature range	−30 to +75°C
Frequency control range	±50 ppm min.
Frequency control voltage	+2.5V ± 2V

Outline drawing

TCO-730C

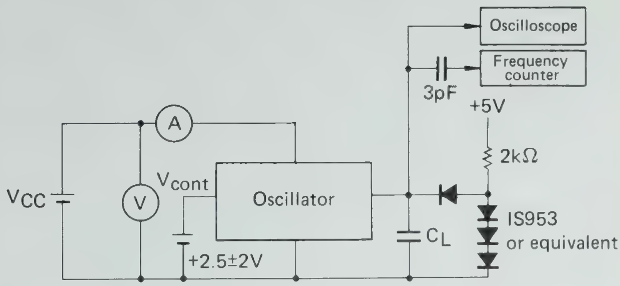


Pin connections

1	Control voltage
7	Common and case
8	Output
14	$+V_{CC}$

Size in mm
(inch)

Test circuit



C_L: Total fixture and probe capacitance = 15pF max.

Crystal Oscillators

TOYOCOM

VCXO TCO-205 Series

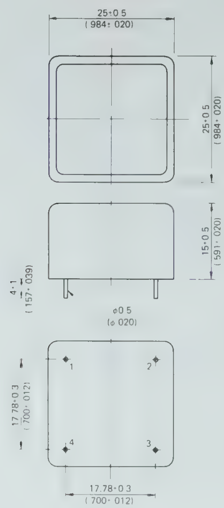
Applications
- Measurement equipment
- Microwave system

Features
- Compact size
- Low SSB phase noise

Model	TCO-205M
Standard frequency	100 MHz
Frequency available range	60 to 150 MHz
Frequency stability vs. Temperature vs. Supply voltage Aging	 ±10 ppm/0 to +50°C ±2 ppm/+12V ± 5% ±5 ppm/year
Supply voltage	+12V ± 5%
Supply current	10 mA max.
Output	0 dBm min. into 50Ω
Operable temperature range	−20 to +70°C
Frequency control range	±20 ppm min.
Frequency control voltage	+3V ± 2V
SSB phase noise	−110 dBc/Hz min. (offset frequency 100 Hz)

Outline drawing

TCO-205M

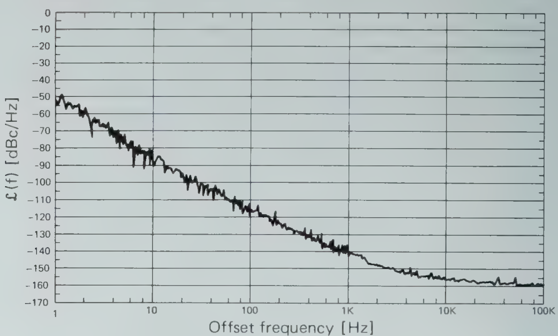


Pin connections

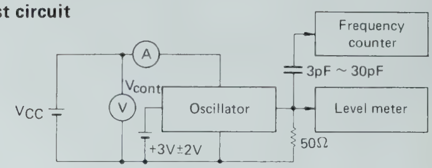
1	Control voltage
2	$+V_{CC}$
3	Output
4	Common and case

Size in mm
(inch)

TCO-205 100 MHz SSB PHASE NOISE



Test circuit



TCXO with modulation function TCO-919 Series

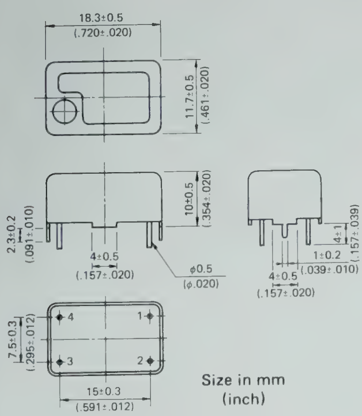
Applications
- Portable radio
- Cellular mobile radio

Features
- Low power consumption (2 mA max.)
- High frequency stability
- With modulation or voltage control function
- Miniature size (2cc)

Model	TCO-919A	TCO-919R
Standard frequency	12.8 MHz	
Frequency stability vs. Temperature vs. Supply voltage Aging	 ±2.5 ppm/−30 to +75°C ±0.3 ppm/+5V ± 5% ±1 ppm/year	
Supply voltage	+5V ± 5%	
Supply current	2 mA max.	
Output	1 Vp-p min. clipped sinewave (DC-cut)	
Operable temperature range	−35 to +80°C	
Frequency adjustment	±3 ppm min. by internal trimmer	
Audio modulation & Vcont function	Audio modulation Deviation : ±8 ppm min. Distortion : 3% max. Input voltage : 2 Vp-p Modulation range : 1 Hz to 3 kHz Response slope : Negative	Vcont for PLL Frequency control range : ±5 ppm min. Control voltage : +2.5 ± 2V Response slope : Positive

Outline drawing

TCO-919A, R



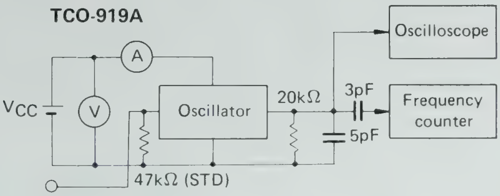
Size in mm
(inch)

Pin connections

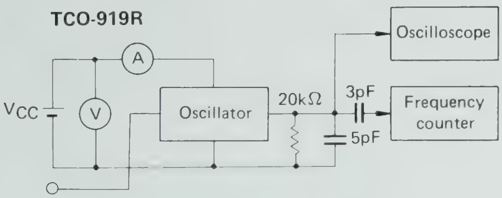
1	Common and case
2	Output
3	$+V_{CC}$
4	Control voltage

Test circuit

TCO-919A



TCO-919R



Crystal Oscillators

TOYOCOM

TCXO TCO-512 Series

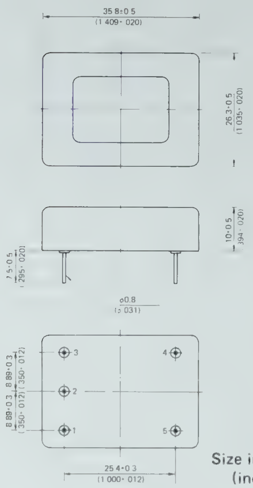
Applications
- Marine radio system
- Frequency synthesizer

Features
- Low power consumption
- Hermetically sealed metal case
- Excellent frequency stability

Model	TCO-512X
Standard frequency	6.4 MHz or 10 MHz
Frequency available range	4 to 25 MHz
Frequency stability vs. Temperature vs. Supply voltage Aging	 ±1 ppm/−10 to +60°C ±0.4 ppm/+10V ± 5% ±1 ppm/year
Supply voltage	+10V ± 5%
Supply current	10 mA max.
Output	Open collector (pull up resistor; 1.5 kΩ)
Operable temperature range	−20 to +70°C
Frequency adjustment	±3 ppm min. by external potentiometer (2.2 kΩ)

Outline drawing

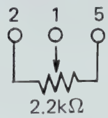
TCO-512 X



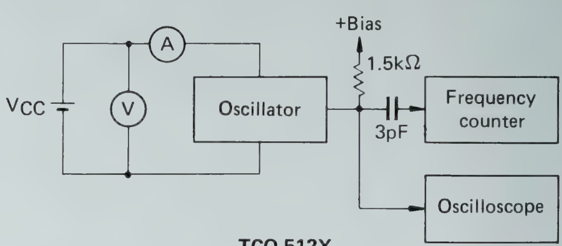
Size in mm
(inch)

Pin connections (TCO-512X)

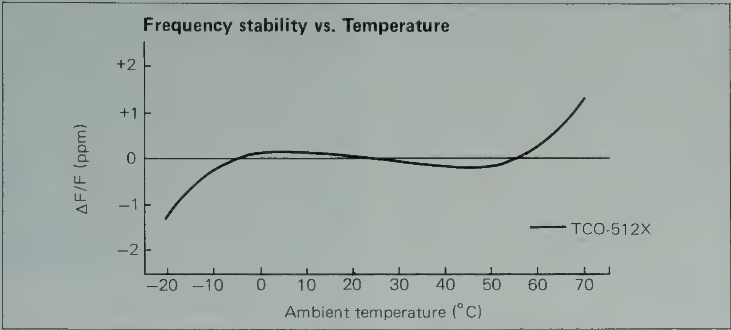
1–2–5	Freq. adj.
3	+Vcc
4	Output
5	Common and case

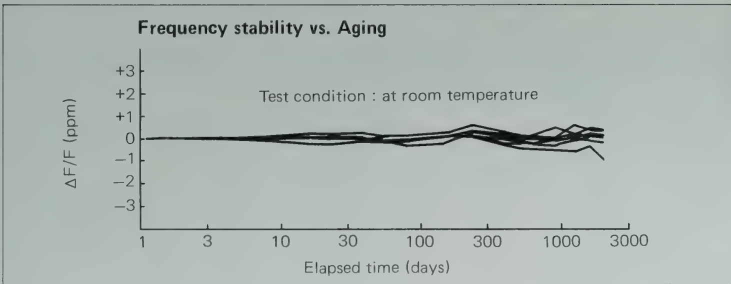


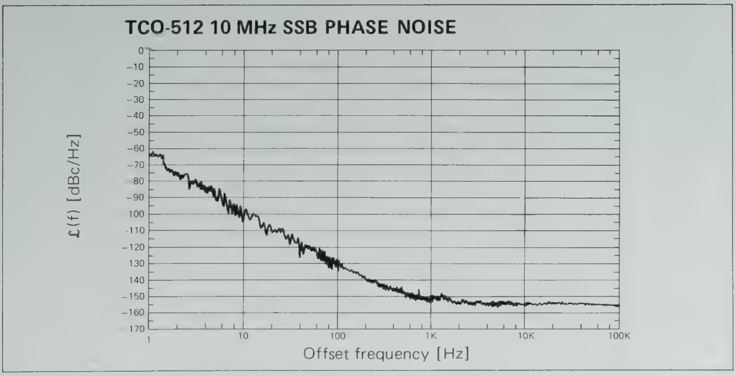
Test circuit

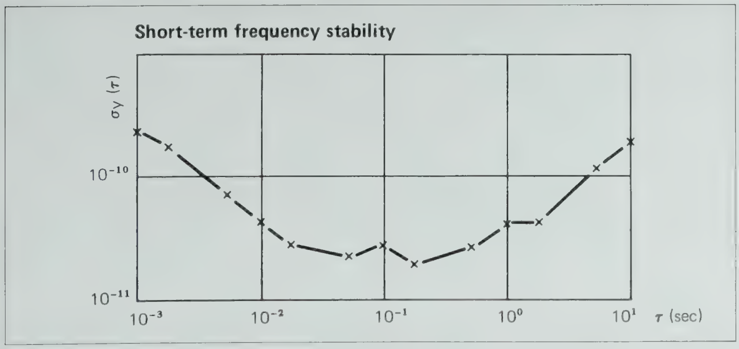


TCO-512X


Frequency stability vs. Temperature
ΔF/F (ppm)
+2
+1
0
−1
−2
−20 −10 0 10 20 30 40 50 60 70
Ambient temperature (°C)
TCO-512X


Frequency stability vs. Aging
ΔF/F (ppm)
+3
+2
+1
0
−1
−2
−3
Test condition : at room temperature
1 3 10 30 100 300 1000 3000
Elapsed time (days)


TCO-512 10 MHz SSB PHASE NOISE
ℒ(f) [dBc/Hz]
1 10 100 1K 10K 100K
Offset frequency [Hz]


Short-term frequency stability
σy (τ)
10⁻¹⁰
10⁻¹¹
10⁻³ 10⁻² 10⁻¹ 10⁰ 10¹ τ (sec)

TCXO with voltage control function TCO-519

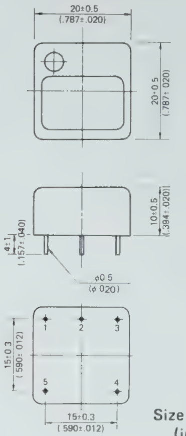
Applications
- Cellular mobile radio
- Trunked radio system

Features
- Compact size
- Wide temperature range
- Excellent frequency stability

Model	TCO-519A	TCO-519L
Standard frequencies	12.8 MHz or 15.36 MHz	12.8 MHz or 15.36 MHz
Frequency available range	10 to 24 MHz	10 to 24 MHz
Frequency stability		
vs. Temperature	±2 ppm/–30 to +85°C	±1 ppm/–20 to +70°C
vs. Supply voltage	±0.2 ppm/+5V ± 5%	±0.2 ppm/+5V ± 5%
Aging	±1 ppm/year	±1 ppm/year
Supply voltage	+5V ± 5%	+5V ± 5%
Supply current	2 mA max.	2 mA max.
Output	1 Vp-p min. clipped sinewave (DC-cut)	1 Vp-p min. clipped sinewave (DC-cut)
Operable temperature range	–35 to +90°C	–30 to +80°C
Frequency adjustment	±3 ppm min. by internal trimmer	±3 ppm min. by internal trimmer
Frequency control range	±6 ppm min.	———
Frequency control voltage	+2.5V ± 2V (positive slope)	———

Outline drawing

TCO-519A, 519L



Size in mm
(inch)

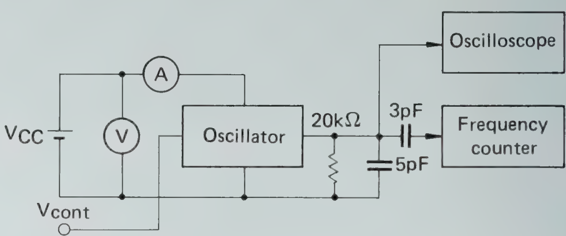
Pin connections
(TCO-519A)

1	+V_{CC}
2	Output
3	Common and case
4	Control voltage*
5	Common and case

Pin connections
(TCO-519L)

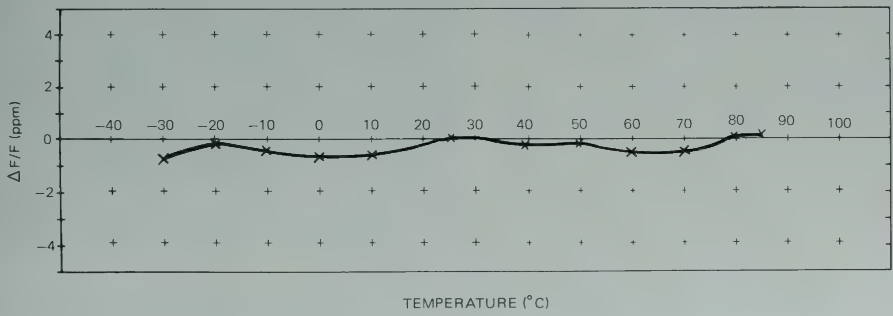
1	+V_{CC}
2	Output
3	Common and case
4	Common and case
5	Common and case

Test circuit

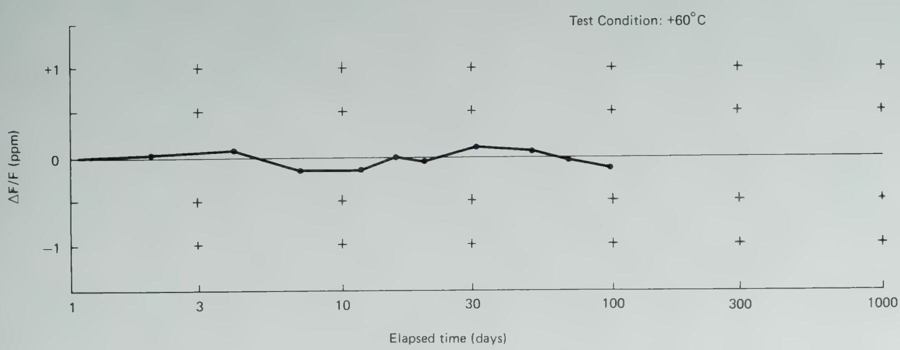


(common and case)

TCO-519A Frequency stability vs. Temperature



TCO-519 12.8MHz Accelerated aging characteristics



Crystal Oscillators

TCXO TCO-909 Series

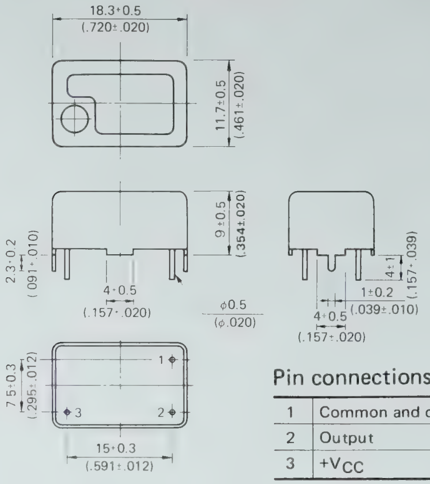
Applications
- Portable radio
- Cellular mobile radio

Features
- Miniature size (2 cc)
- Low power consumption (2 mA max.)
- High frequency stability

Model	TCO-909Z
Standard frequencies	12.8 MHz or 15.36 MHz
Frequency available range	10 to 20 MHz
Frequency stability vs. Temperature vs. Supply voltage Aging	 ±2.5 ppm/–30 to +75°C ±0.3 ppm/+5V ± 5% ±1 ppm/year
Supply voltage	+5V ± 5%
Supply current	2mA max.
Output	1 Vp-p min. clipped sinewave (DC-cut)
Operable temperature range	–40 to +85°C
Frequency adjustment	±3 ppm min. by internal trimmer

Outline drawing

TCO-909Z

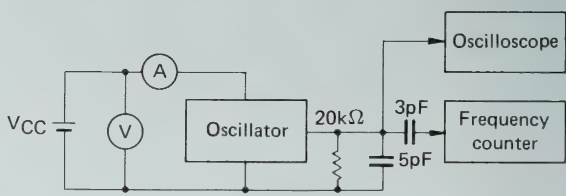


Pin connections

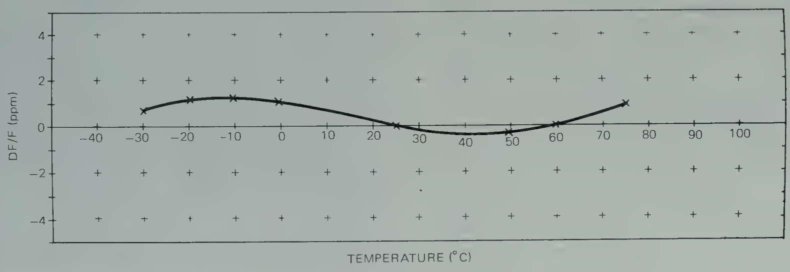
1	Common and case
2	Output
3	$+V_{CC}$

Size in mm
(inch)

Test circuit

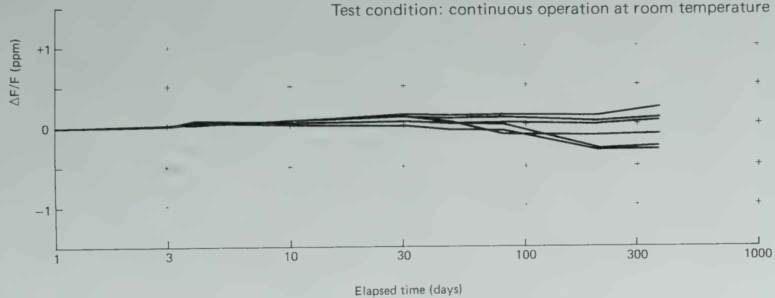


Frequency stability vs. Temperature

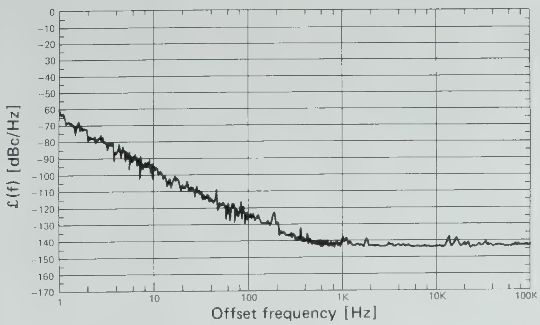


Aging characteristics

Test condition: continuous operation at room temperature



TCO-909 12.8 MHz SSB PHASE NOISE



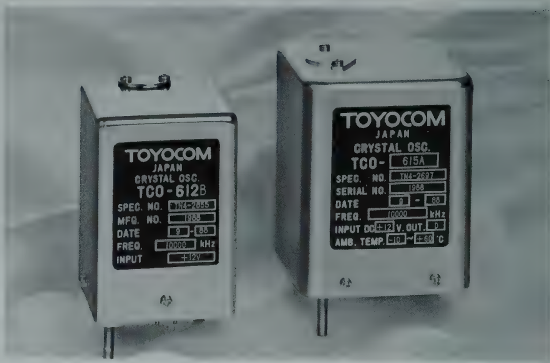
Crystal Oscillators

TOYOCOM

OCXO TCO-612, TCO-613, TCO-615 Series

Applications
- Mobile telephone base station
- Satellite communication system
- Satellite navigation system
- Frequency counter & synthesizer

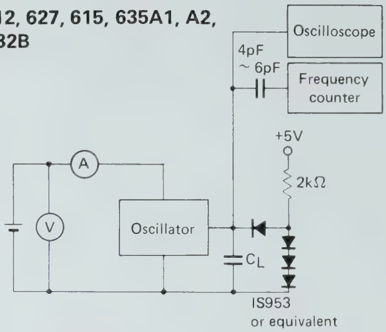
Features
- Excellent long and short term stability
- Low SSB phase noise
- Excellent warm-up
- Compact size



Model	TCO-612A	TCO-612B	TCO-612C	TCO-613A	TCO-615A	TCO-615B
Standard frequencies	5 MHz or 10 MHz			5 MHz	5 MHz or 10 MHz	5 MHz
Frequency available range	1 MHz to 10 MHz			5 to 7 MHz	5 to 10 MHz	———
Frequency stability vs. Temperature	$\pm 1 \times 10^{-7}$	$\pm 5 \times 10^{-8}$		$\pm 1 \times 10^{-8}$		$\pm 5 \times 10^{-9}$
	–10 to +60°C					
vs. Supply voltage	$\pm 1 \times 10^{-7}$	$\pm 3 \times 10^{-8}$		$\pm 5 \times 10^{-9}$	$\pm 2 \times 10^{-9}$	$\pm 1 \times 10^{-9}$
	±10%			±5%		
Aging per day	$\pm 5 \times 10^{-8}$	$\pm 2 \times 10^{-8}$	$\pm 5 \times 10^{-9}$	$\pm 2 \times 10^{-9}$	$\pm 2 \times 10^{-9}$	$\pm 5 \times 10^{-10}$
per year	$\pm 2 \times 10^{-7}$	$\pm 1 \times 10^{-7}$	$\pm 8 \times 10^{-8}$	$\pm 5 \times 10^{-8}$	$\pm 5 \times 10^{-8}$	$\pm 2 \times 10^{-8}$
	after 24 hours operation			after 48 hours operation		
Warm-up	$\pm 1 \times 10^{-7}$	$\pm 5 \times 10^{-8}$		$\pm 2 \times 10^{-8}$	$\pm 5 \times 10^{-8}$	
	within 10 minutes at 25°C			within 30 minutes at 25°C		
Supply voltage	+12V ± 10%					
Supply current Warm-up	330 mA max.			400 mA max.	500 mA max.	
Steady state at 25°C	150 mA max.			200 mA max.	300 mA max.	
Output	TTL Compatible, Fan-out 2			2 Vp-p/50Ω Sinewave	TTL Compatible, Fan-out 2	
Frequency adjustment	$\pm 5 \times 10^{-7}$ min.			$\pm 2.5 \times 10^{-7}$ min.	$\pm 1 \times 10^{-7}$ min.	
Weight	100 grams			200 grams		

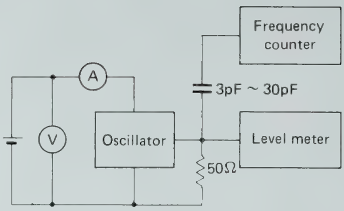
Test circuit

TCO-612, 627, 615, 635A1, A2, 632B

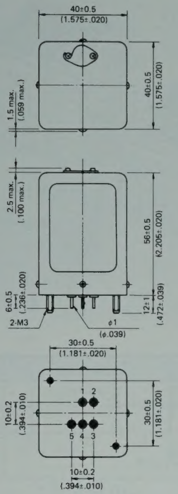


C_L: Total fixture and probe capacitance = 15pF max.

TCO-613, 635A



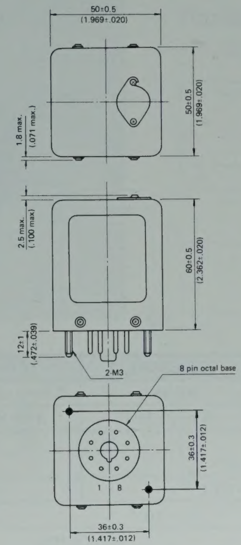
TCO-612A, B, C



Pin connections

1	Output
2	$+V_{CC}$
3	NC
4	NC
5	Common and case

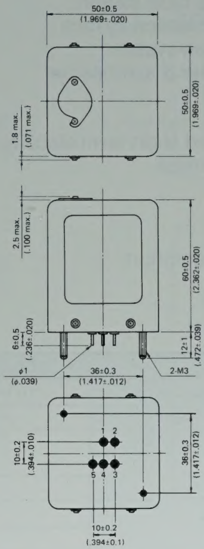
TCO-613A



Pin connections

1–3	NC
4	Output (hot)
5	Output (cold)
6	Common and case
7	$+V_{CC}$
8	NC

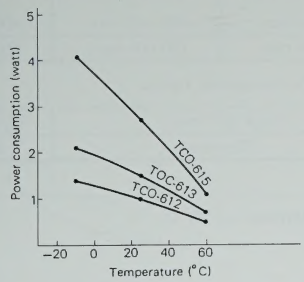
TCO-615A, B



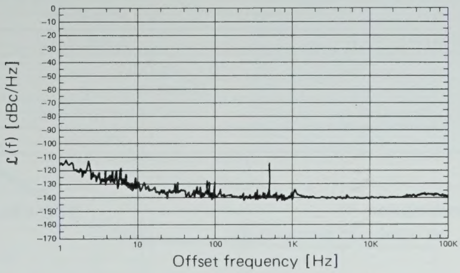
Pin connections

1	Output
2	$+V_{CC}$
3	NC
4	NC
5	Common and case

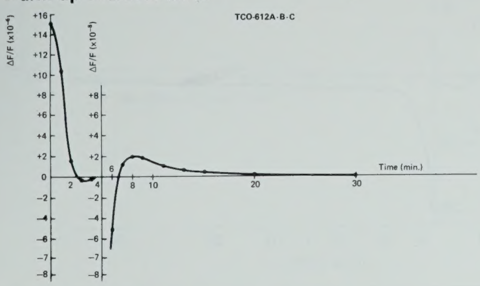
Power consumption vs. Ambient temperature



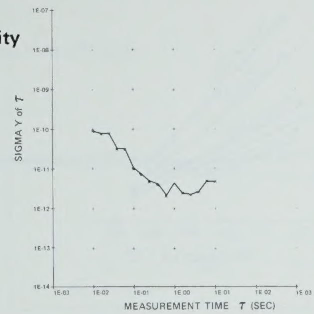
TCO-613A 5 MHz SSB PHASE NOISE



Warm-up characteristics



TCO-615 5 MHz Short-term stability



Crystal Oscillators

TOYOCOM

OCXO TCO-635, TCO-627, TCO-632 Series

Applications

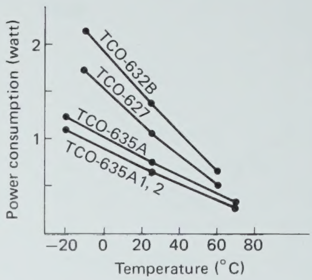
- Mobile telephone base station
- Satellite communication system
- Satellite navigation system
- Frequency counter & synthesizer

Features

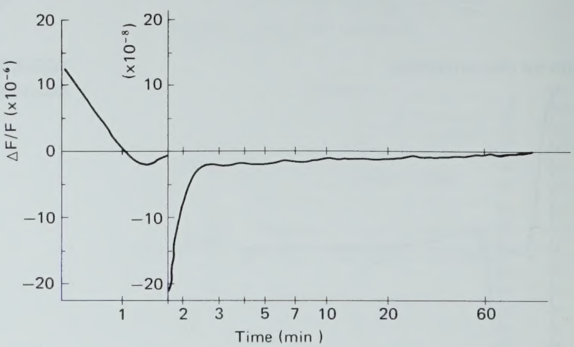
- Excellent long and short term stability
- Low SSB phase noise
- Fast warm-up
- Miniature size
- Low profile
- Low power consumption

Model	TCO-635A	TCO-635A1, 2	TCO-627B	TCO-627F	TCO-632B
Standard frequencies	10 MHz	10 MHz	5 MHz or 10 MHz	6.4 MHz	10 MHz
Frequency available range	–	5 to 25 MHz	4 to 10 MHz	–	–
Frequency stability vs. Temperature	$\pm 1 \times 10^{-7}$		$\pm 5 \times 10^{-8}$		$\pm 3 \times 10^{-8}$
	−20 to +70°C		−10 to +60°C		
vs. Supply voltage	$\pm 3 \times 10^{-8}$			$\pm 5 \times 10^{-8}$	$\pm 5 \times 10^{-9}$
	+12V ± 10%				+12V ± 5%
Aging per day	$\pm 2 \times 10^{-8}$	$\pm 2 \times 10^{-8}$	$\pm 2 \times 10^{-8}$	$\pm 2 \times 10^{-8}$	$\pm 5 \times 10^{-9}$
per year	$\pm 2 \times 10^{-7}$	$\pm 2 \times 10^{-7}$	$\pm 1 \times 10^{-7}$	$\pm 1 \times 10^{-7}$	$\pm 5 \times 10^{-8}$
	after 24 hours operation				
Warm-up	$\pm 5 \times 10^{-8}$		$\pm 5 \times 10^{-8}$	$\pm 2 \times 10^{-7}$	$\pm 2 \times 10^{-8}$
	within 5 minutes at 25°C		within 10 minutes at 25°C	within 5 minutes at −10°C	within 30 minutes at 25°C
Supply voltage	+12V ± 10%				+12V ± 5%
Supply current Warm-up	150 mA max.		330 mA max.	550 mA max.	400 mA max.
Steady state at 25°C	70 mA max.		120 mA max.	120 mA max.	150 mA max.
Output	+8 ± 2dB/50Ω Sinewave	TTL Compatible, Fan-out 2			
Frequency adjustment	$\pm 1 \times 10^{-6}$ min.		$\pm 5 \times 10^{-7}$ min.		$\pm 3 \times 10^{-7}$ min.
Weight	30 grams		80 grams		100 grams

Power consumption vs. Ambient temperature

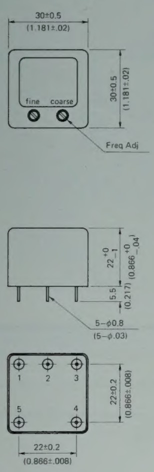


TCO-635A Warm-up characteristics at 25°C



Outline drawing   Size in mm (inch)

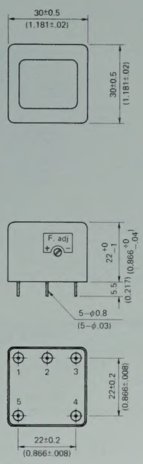
TCO-635A, A1



Pin connections

1	NC
2	NC
3	Common and case
4	Output
5	+V_{CC}

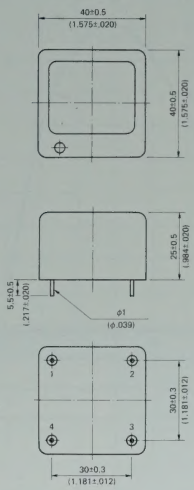
TCO-635A2



Pin connections

1	NC
2	NC
3	Common and case
4	Output
5	+V_{CC}

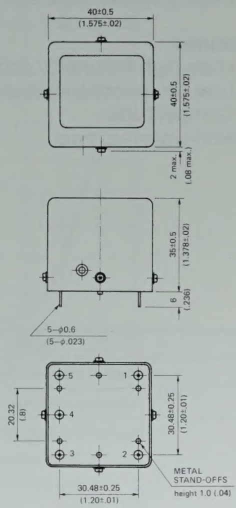
TCO-627B, F



Pin connections

1	NC
2	Output
3	+V_{CC}
4	Common and case

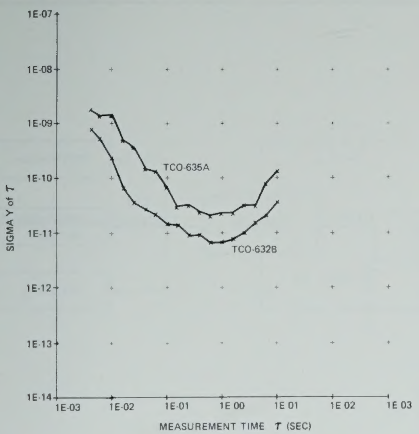
TCO-632B



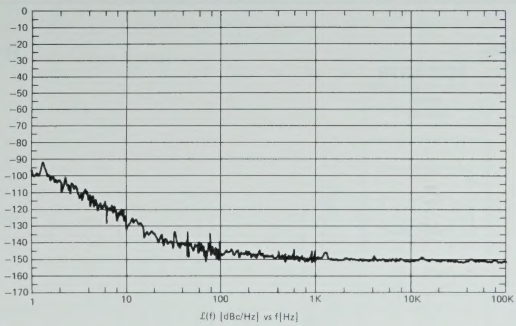
Pin connections

1	Common and case
2	Output
3	+V_{CC}
4	Common and case
5	NC

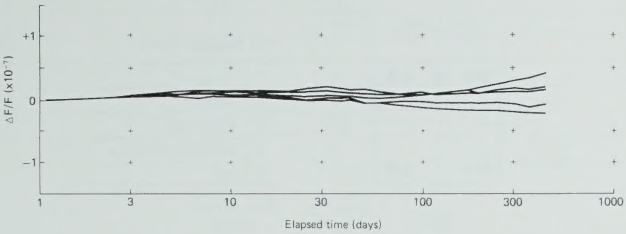
Short-term stability



TCO-635A2 10 MHz   SSB PHASE NOISE



TCO-635A 10 MHz   Aging characteristic



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